CANON TECHNOLOGY HIGHLIGHTS 2011

With eyes on becoming the global leader in imaging technology…

Since its very beginnings, Canon has worked to develop and accumulate innovative technologies that lead the times — technologies that make dreams come true and contribute to a sustainable global environment and society.

The technologies Canon has developed and accumulated have had one consistent theme — ‘imaging.’

Canon has eyes on becoming the global leader in imaging technology with the aim of contributing to the evolution of mankind.

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Message from the President

Contributing to business development and more comfortable lifestyles through advancements in imaging technology

Creating new value with cross-media imaging

Since its foundation, Canon has striven to create new value for society in the form of revolutionary products and unique, innovative technologies. Our history is truly one of technological development.

In addition, we are moving forward with our cross-media imaging strategy, which aims to enable people to realistically reproduce their thoughts and dreams at will through images and information, spanning time and space to facilitate creative fulfillment.

Under this cross-media imaging strategy, we have boosted efforts to further enhance input and output devices, as well as the various supporting technological platforms upon which they rely, such as image processing and color management. At the same time, we are working to realize further advances in a range of technologies, including user-interface, transmission, networking, image-recognition, and image-search technologies, in order to achieve sophisticated synergies between products and deliver new value along with new solutions.

In this way, we are striving to further refine management quality, and we embrace the challenge of guiding Canon back to a new growth track.

Innovation that benefits the *kyosei* society

Canon's corporate philosophy is *kyosei*, which refers to all people, regardless of race, religion or culture, harmoniously living and working together into the future.

One of Canon's major strengths lies in the company's production capabilities. Moving forward, we hope to continue contributing to global prosperity and human well-being by further developing technologies that will benefit society in the future. We also hope that, through technological innovation, we can contribute to the resolving of global environmental problems.

Additionally, armed with a strong will, we are working to further boost our ability to achieve the highest levels of quality. It would be safe to say that it is Canon's very nature to continue delivering in a timely manner products marked by outstanding design, ease of use, functionality, reliability, durability, and cost performance.

Promoting R&D for next-generation technologies

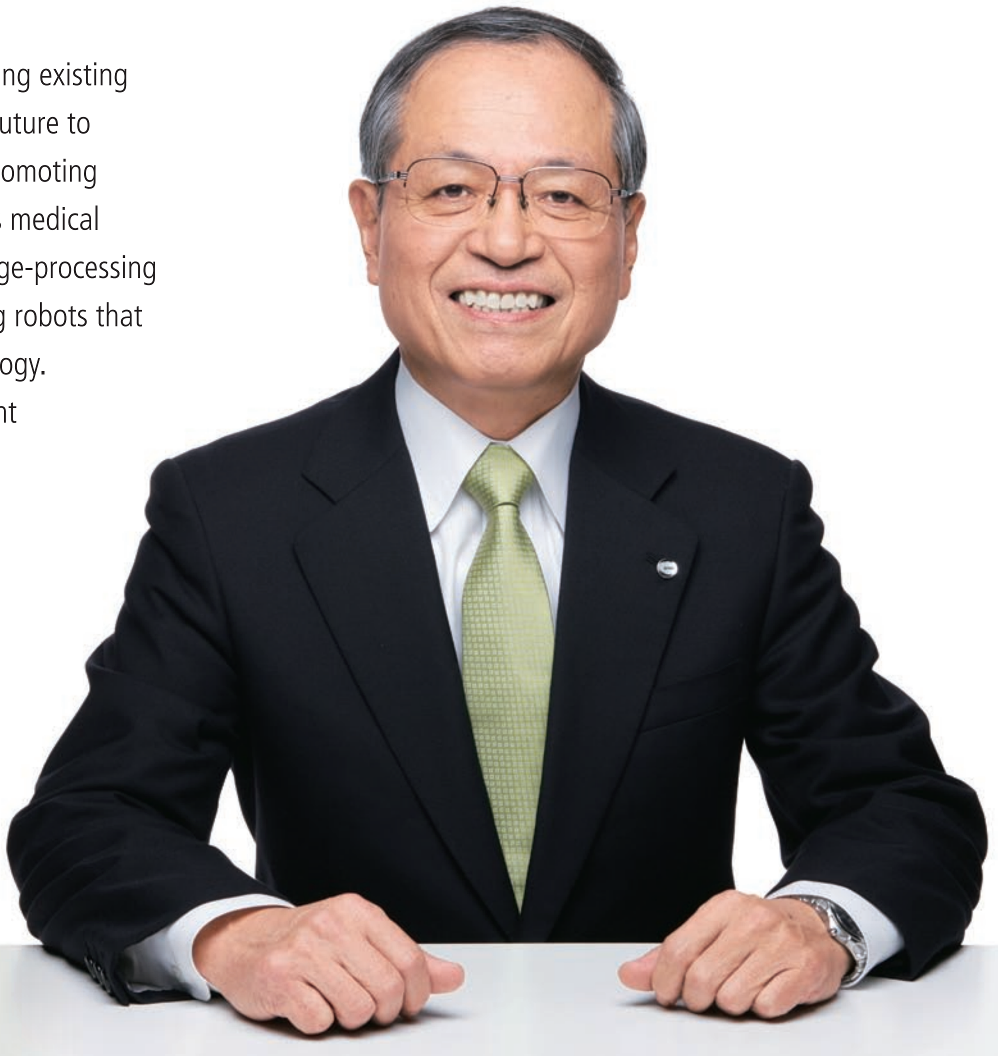
To date, Canon has created core product technologies in such fields as image capture and electrophotography by combining mechatronics, electronics, fine chemicals, and other disciplines around a core focus on optics. We have also improved our commercialization technologies and enhanced our technologies in manufacturing and other areas to launch a host of highly competitive value-added products.

In addition to strengthening and expanding existing businesses, we have set our sights on the future to provide society with new forms of value, promoting research and development in such areas as medical imaging employing optical-sensor and image-processing technologies, and intelligent manufacturing robots that makes use of super machine vision technology.

With the aim of becoming a truly excellent global company, Canon will do its all in pursuit of further technological innovation.

Tsuneji Uchida

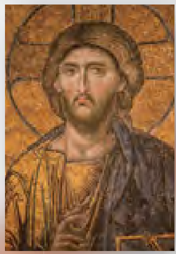
Tsuneji Uchida
President & COO
Canon Inc.

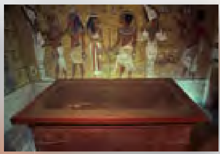


Imagining the Future of Imaging

The Genesis of Painting

The oldest known paintings by man are the cave paintings of the Upper Paleolithic era (about 40,000 years ago), which have been found on the walls and ceilings of caves around the world.





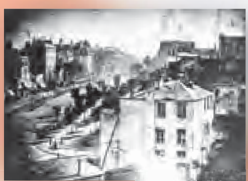
The Creation of Linear Perspective

Perspective drawing, which was invented in the 15th century, blossomed during the Renaissance. It later formed the foundation of Western art as an important technique in realism.

Imaging Evolving in Step

Recording Events through Pictures and Photographs

Man's earliest known attempts at imaging were the Paleolithic cave paintings, such as those found at Lascaux, France. They progressed to the tomb paintings of ancient Egypt, religious icons, the art of the Renaissance and beyond. It is a history of man's ceaseless pursuits of ways and means to capture events, depict feelings and find expression for his imagination. Such efforts eventually gave rise to the emergence of a new method of imaging – that of chemically recording and fixing images through photography as developed by Louis Daguerre. Following the development of silver halide photography and optical technology, we arrive at the present with its digital imaging information devices.



The Invention of Photography

Photography, invented in the 19th century by Nicéphore Niépce and Louis Daguerre, spread rapidly, replacing portrait paintings in popularity.

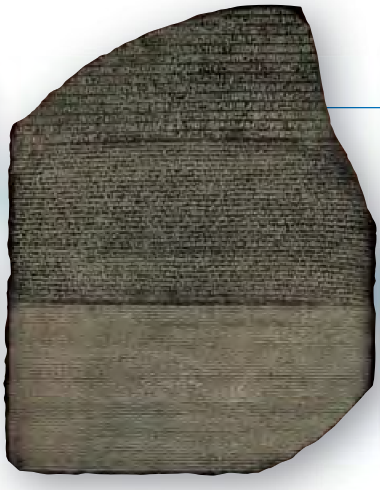
(The Bridgeman Art Library Collection)

Hansa Canon (1936)

The Birth of Impressionism

The invention and spread of photography triggered the decline of realist paintings. A new movement – driven by technical innovation (paint in tubes) and inspired by Japanese *ukiyo-e* prints – took shape in the West.

While imaging was the product of man’s imagination, its progress prompted the development of culture, art and science, and made a significant contribution to the evolution of mankind. The cross-media imaging strategy that Canon pursues will further advance the imaging technology pursued by man. For Canon, imaging includes not only images but also documents. In this segment we provide an overview of imaging both as a ‘visual recording of events’ and a ‘recording of information by text’ and explore the future vision and the possibilities of imaging technology as imagined by Canon.



The Dawn of Writing

Writing as a means of recording information was first seen around 3500 B.C. in the form of the cuneiform script used by the Sumerian peoples of Mesopotamia. (On right: The Rosetta Stone)

with Mankind

Recording Information by Text

The birth of writing was an epoch making development in the recording of information. The cuneiform script of Mesopotamian civilization gave mankind a means to represent spoken language visually and to record information with certainty. The speed at which written works were created was dramatically accelerated through the subsequent development of paper and further spurred by Johannes Gutenberg’s invention of movable type printing technology. This marked the beginning of the era of the mass production of information.

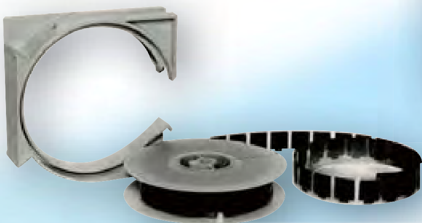
In modern times, the world has seen desktop publishing spread explosively beginning in the 1980s through the digitization of information. Today, the advancement of digital and network technologies and the digitization of all manner of information and documents are creating new possibilities in the way information is used and handled.

The Launch of Movable Type Printing

The movable type printing press was invented by Johannes Gutenberg around 1440. In 1445, Gutenberg succeeded in printing the *42-line Bible*, the first book in the world to be printed by movable type printing.

(University of Tsukuba Library Collection)

NP-1100 (1970)



The Invention of Microfilm

In the mid-19th century, René Dagron acquired a patent for microfilm. This was the beginning of efforts toward the storage of vast amounts of information in an alternative format and of mechanisms for retrieving information.

From Records to Memories

Recording Events through Pictures and Photographs

Mankind has used paintings as a means to record facts or express his feelings since prehistoric times. This innate desire to preserve and share impressions with others was first realized through cave paintings.

The subject matter and artistic techniques changed over time to include religious paintings and landscapes. What has remained constant, however, is man's eagerness to record and convey events. In this respect, the invention of photography in the late 19th century was a revolutionary development in imaging technology. The recording of events has further evolved rapidly in recent years with advances in digitization technologies that have enabled greater freedom in the handling of video and still images.

Canon, too, has contributed to the evolution of the recording of events through its development of various products from both the perspective of that which man seeks to capture and the forms in which he preserves this.

Canon's Vision of the 'Recording of Events'

Canon has consistently focused on the realization of high picture quality as the performance of cameras and other recording equipment becomes more and more sophisticated. But this is only one aspect of the company's vision of technological development. Canon believes that what people seek when taking photographs or shooting video is not a simple 'record' of events. Rather, they are trying to capture their enduring impressions and memories of the event.

Major developments in the technology of photography have resulted from advances in optical and image recording technologies. Today's technology allows users to capture specific moments and realistically duplicate spatial effects and hues. People's desires on one level – to accurately record events – are being satisfied to a high degree now that photographic film has been replaced by digital imaging sensors which achieve even higher definition.

What then is the path that Canon should take as digital technology burgeons? One of the directions that Canon has identified is new to the field of imaging: to go from mere records to real memories.

The recording of video has also begun to evolve. DIGIC 4 is involved in the optimum image processing of not only still images but also video.

DIGIC 4 Image Processor

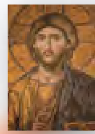
Breathing Life into our Impressions

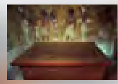
Canon believes that imaging can do much more than just give a visual record of things; it can bring life to people's important memories.

A child's birthday party, for example. When a video of the party is viewed several years later, it is the memory and enjoyment of that day that people recall. In instances like this, the smile on the child's face and the joy expressed through his or her actions are more important than the decorations in the background.

People select and focus – without thinking – on what is at the center of their attention. We believe Canon's role is to help people relive their lasting memories as they saw it in their mind's eye instead of simply making a faithful reproduction of the scene.

This approach is already starting to be realized through a wide variety of techniques. There are a myriad of ways to express this: reproducing colors – the blue of the sky or the deep green of a forest – that are close to how one remembers them. Recognizing what the most important subject is and automatically making the subject the center of focus. Easier framing of the scene or softening of the background focus. Such techniques, which were once only available to professional photographers, have been made available to the novice, allowing him or her to recreate the desired effect to keep as recorded media.





Greater Freedom of Expression

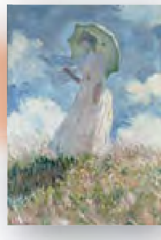
Canon's aspiration in the new world of imaging is to let people's imagination fly free.

With the passage of time, images and impressions are etched ever more deeply in our minds each time they are recalled. This is because unlike cameras or lenses, people bring their feelings to bear when they look at something.

Canon seeks to add to the series of video processes – from shooting to editing and final images – functions to enable this 'expression of impressions.' The goal is to create records of lasting impressions and memories that capture more than the simple physical truth.

If we are to reproduce our impressions, the camera must be able to express the timing and focus of the heart. This would have the potential to enrich peoples' sensibilities and powers of expression without the usual limits of time and space when shooting video.

From mere records to real memories, the story of imaging, the recording and preservation of events in images continues to evolve.



Recording Events through Pictures and Photographs

An Approach to Creating New Value in Imaging

Multidimensionality – and the possibility it affords of enhanced understanding and visualization – is a key point in exploring the possibilities of imaging.

In the case of still or video cameras, multidimensionality denotes the simultaneous processing of not only the image of the object recorded but also related information, such as distance, location and time. We can think of it as the 'comprehension' of the object and the processing of its image using different types of information.

Multidimensionality also refers to the combination of massive quantities of information sources, such as databases, and reorganizing and structuring the information using new categories. The multifaceted association of information gives new meaning to the information and makes it possible to use the information in ways that meet the needs of users.

The multidimensionality of imaging further advances the ability to recognize and retrieve images and documents, and it leads to greater intelligence in automated functions. An example is the capacity to surmise the intentions of the user.

Multidimensionality also enables us to map in 3D the facts and figures of information we are recording in an easy-to-understand manner. It shows us a world that cannot be seen through just a single type of image data, and so expands the scope of our visualization.

This approach opens up a wide range of possibilities for the use of images and documents, stimulates people's ideas and self expression and creates new values in imaging.

From Information to Meaning

Recording Information by Text

The desire to understand and share information in a universally recognizable form has resulted in the birth of written characters and the development of means for their inscription, such as on clay, papyrus, paper and the various recording media of today.

Meanwhile, invention of the movable type printing press facilitated the mass reproduction, diffusion and transmission of documents. The sharing of information became commonplace as a result of progress in such technology.

The accumulation of knowledge and information was realized as libraries, which have their beginnings in ancient Egypt, and the information stored has become an asset for all of mankind. Library classification systems, such as the Dewey Decimal Classification that appeared in the 19th century, were created as means of information retrieval. Back then, the handling of information was a technology in itself.

It was after the advent of electronic technology that a significant transformation was seen in the handling of printed information. For example, the popularization of copying machines, printers and desktop publishing – focused around the personal computer – has resulted in an age in which we can now freely process and edit documents printed on paper.

The evolution of digital technology has created a system that is able to handle the complete process, from the input to output of documents. It has also accelerated the digitization of all information and documents, opening new possibilities in the handling of information.

Canon, too, has been contributing to the growth of the recording, processing and editing of information by continuously developing new systems, beginning with analog copying machines and including scanners, laser printers and network digital MFPs.

Canon's View of Recorded Information

Canon sees the value of recorded information as its content and what it signifies. It has therefore redefined documents in terms of its 'meaning' rather than as superficial bits of information.

When we think of 'information,' we visualize data and descriptions of events. However, it is the meaning imparted by the information rather than superficial words which is of importance.

As such, it is not enough to collect and organize massive amounts of information and make the information easily retrievable. Today, virtually all of the information in the world lies at our fingertips through the Internet. In order to find information of value from the vast amount of information, it becomes increasingly important that we are able to handle the 'meaning' contained in the information.

Furthermore, being able to freely handle printed and digitized information seamlessly makes it possible for information to be reused, thereby increasing its value.

Canon has been involved in the research and development of various document-related cutting-edge technologies. Of these, we have already applied to practical use, propriety recognition, concept search and other technologies that enable the freer handling of the 'meaning' contained in information. Canon continues to carry out research and development in such technologies.

Greater Convenience Means Greater Creativity

It is the meaning in information which people want to communicate. When giving shape to the 'meaning,' it becomes even easier to search for and identify necessary information if we can visualize how the information is organized and structured.

For example, it becomes possible to generate, from a paper document, an electronic document that can be organized and stored as a reusable information asset. This can be done by separating the paper document into text and image segments through automatic analysis.

Furthermore, through the use of technology for searching and analyzing 'meaning,' it also becomes possible to automatically extract and classify headings, text and handwritten text, add new associated information, or execute visualization comprehensibly.

By adding the appropriate analytical focus that matches the intent of the user, it becomes easy to obtain the optimum information that matches the user's needs. And, by supporting the thought processes of the user and realizing his or her requirements, it becomes possible to increase the convenience of the user by releasing him or her from time-consuming peripheral tasks. They can then concentrate on the task in hand and on being creative. This world of imaging as visualized by Canon is steadily evolving.

Recording Information by Text

Canon’s Imaging Technology, Evolving amid Digitization

Canon has continually pursued imaging technology and grown together with the development of imaging. The company has contributed to the expression of creativity through technology that supports users’ styles, ideas and passion.

While involved in imaging and documents, these two areas are by no means unrelated. The rapid development of digital and networking technology, together with the establishment of a social infrastructure centered on IT, have made it possible to handle images and documents seamlessly as recorded ‘information.’

Canon’s camera and business machine fields were considered completely separate realms during the analog era until their integration began in the digital age. Today, new possibilities are arising in expression and creativity through unified input-output devices and the continual evolution of imaging technology.

The growth of new forms – such as cloud computing – of IT systems use is also strongly linked to our input-output devices. Canon has been consistently involved in technological development that spans both the input and output of recorded information, and this is why the company is able to provide optimized services even within new network environments.

“Canon is now aiming for a future in which people are able to realistically reproduce their thoughts and dreams at will through images and information, spanning time and space to facilitate creative fulfillment.” …Canon, through its continual pursuit of imaging technology, aspires to contribute to the advancement of society by expanding the dimensions and possibilities that are contained in images and information.

Visualization Technology

New Horizons in Medical Imaging

To date, Canon has been engaged in the development of a broad range of visualization technologies with the ultimate aim of making the invisible visible. Now, armed with visualization technologies employing revolutionary sensor and image-processing technologies, Canon is setting its sights on medical imaging development, and in doing so, continues to set the pace in the imaging-technology field.

Canon's Involvement with Medical Equipment

In 1940, three years after the company's establishment and following the successful development of a 35-mm camera product, Canon launched its first indirect X-ray camera. This was also the first X-ray camera to be produced in Japan and, as such, became indispensable in the early detection of tuberculosis, which, at that time, remained a significant threat to public health. Since then, Canon's commitment to high-quality imaging through the leveraging of its expertise in the fields of optics, precision, device, and image-processing technologies has led to success in the development of such medical equipment as digital X-ray systems (→ P.55), winning the company an enviable reputation within the medical industry.

Making Possible the Detection of Invisible Cancer Tissue

Thorough Examinations Made Convenient at Your Local Clinic

Medical devices (or modalities) capable of producing tomograms or 3-D images of a patient's organs in a noninvasive fashion are playing an essential role on the healthcare front. Widely used in applications such as cancer diagnosis and brain scans, these modalities contribute greatly to modern medicine and, as a result, have seen a remarkable boost in popularity in recent years.

Nevertheless, a number of issues remain. For instance, today's modalities normally rely on technologies such as X-ray computed tomography (CT), MRI (magnetic resonance imaging), and PET (positron emission tomography), making them both large and expensive. And given concerns over exposure to X-rays and other potential effects on the human body, such equipment must be set up in specially controlled areas within medical facilities, demanding special consideration when determining floor plans. Therefore, these systems can only be installed in large hospitals.

Against this backdrop, Canon is fully engaged in the development of new medical imaging technologies as part of its quest for ubiquitous medical treatment. In specific terms, it is hoped that the skilful application of cutting-edge technologies will make it possible to realize medical treatment environments that are more convenient than ever before.

Canon envisages modalities with:

- Compact designs and significantly lower prices than conventional devices
- Radiation-free, noninvasive emission sources that pose no threat to human health
- Ease-of-use for added convenience in diagnoses conducted by medical doctors and operators

Taking full advantage of imaging technology perfected over many decades, Canon is working to develop totally new modalities that can greatly benefit cutting-edge medical treatments.

Canon looks forward to an era where even local clinics will provide access to diagnosis devices capable of detecting cancer tissues that had never previously been visible.

The CK Project

The CK Project aims to achieve advances in medical-imaging research and development. Launched in 2006 as a collaborative undertaking between Canon and Kyoto University — the C and K in the project's name — this project is part of the *Formation of Innovation Center for Fusion of Advanced Technologies* program sponsored by Japan's Ministry of Education, Culture, Sports, Science and Technology. The ten-year project targets practical applications for research, beginning with fundamental research.

Under the CK Project, a team of several dozen members comprising Canon engineers and Kyoto University researchers in the fields of medicine, engineering, pharmaceuticals, and IT work together to tackle advanced, wide-ranging challenges in the research and development of diagnostic solutions utilizing medical imaging.

The six major research themes currently under way are as follows.
- OCT (optical coherence tomography) for retinal examinations
- Optical ultrasound imaging for breast cancer diagnosis
- Medical-imaging diagnostic support for physicians
- Molecular probe contrast agents for enhanced modality diagnosis performance
- Atomic magnetometers — a core solution for biomagnetism measurement
- Bio-imaging devices for improved modality performance

The CK project entered its second phase in 2009. Additionally, in the fields of OCT and optical ultrasound imaging, a step-up in research was realized in the spring of 2010 with the start of clinical trials. With physicians from Kyoto University Hospital's departments of Ophthalmology, Breast Surgery, and Diagnostic Radiology now joining the project, trial data from actual patients are being carefully collected and analyzed.

Delivering Modalities from Japan to the World

In optical ultrasound imaging, the core technology centers around light — an area in which Canon excels. This imaging approach involves the capture of ultrasonic signals produced by a tissue when it is exposed to light, and using these signals to produce 3-D images. As of August 2010, however, there are no modalities that make use of this technology.

While optical ultrasound imaging offers potential in a variety of medical fields, Canon initially aims to deploy this technology in mammographies for breast-cancer detection.

By pursuing a light-based approach to mammographies, Canon aims to remove all concern over exposure to radiation during examinations and lessen the burden on the patient. Meanwhile, modalities developed using optical ultrasound imaging will also be smaller and less expensive than those in use today.

Additionally, optical ultrasound imaging enables the detection of the type of early-stage lesions that are often missed by conventional technologies. In fact, given the potential for reducing the minimum detectable tumor size, in addition to diagnosis, treatment and many other uses may be made possible through the integration of optical ultrasound imaging in endoscopic procedures in the future.

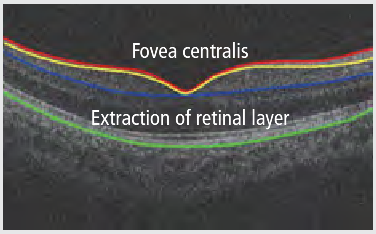
Furthermore, Canon is making additional advances in research into molecular probes and medical-imaging diagnostic support, the latter being a new form of CAD (computer-aided diagnosis) that is currently the

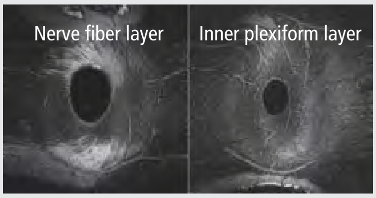
Medical Imaging Approach No. 1

Optical Coherence Tomography (OCT)

Early Detection of Lifestyle-Related Diseases through Retinal Examination

Optical coherence tomography works by taking cross-section images of the retina using near infra-red light interferometry. Through the development of adaptive optics mirrors, new light sources, and other similar elements, Canon has been able to significantly increase resolution and make dramatic improvements in imaging speed. Further enhancing the resolution of OCT allows for finer images of the retina, blood vessels, and other body parts and also facilitates more accurate measurement. This will make it possible to spot signs of lifestyle-related diseases within the retina, such as abnormalities produced by diabetes, at a very early stage through regular examinations. Canon aims to commercialize this technology in advanced retina diagnosis equipment designed to the world's highest standards.





Example of High-Precision OCT Imaging

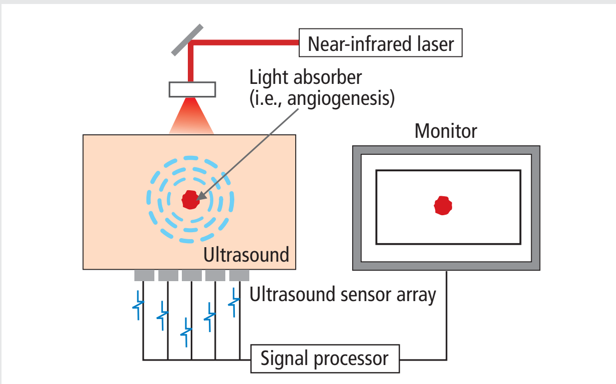
Medical Imaging Approach No. 2

Optical Ultrasound Imaging

Diagnostic Device for Detecting Cancer from Angiogenesis (New Blood Vessels)

These devices are used for internal visualization of the human body using the photoacoustic effect. The photoacoustic effect is a phenomenon whereby tissue produces ultrasound as a result of its absorption of light energy and its subsequent thermal expansion. Using near-infrared laser as the light source and new sensors to detect the generated ultrasound, blood vessels can be seen without the need for a contrast medium. The identification of angiogenesis using this technology makes possible the early detection of cancer.

Canon is aiming to provide assistance in the early detection of breast cancer and related malignancy diagnoses in its development of optical ultrasound imaging technologies. And as it allows tumors to be observed, the company also hopes that this technology will prove useful when making decisions regarding treatment methods. At present, Canon is working towards clinical trials through fundamental research in the form of animal testing.



Conceptual View of Optical Ultrasound Imaging

focus of much attention. Because they can quantitatively analyze lesions based on the thousands of individual images typically produced during a single examination, these CAD systems contribute to reduced physician workloads, another reason why they are in demand. What's more, through image fusion, this approach boosts the rate of lesion detection and ensures an extremely high level of diagnostic consistency that does not hinge on the skill or experience of the doctor in the same way as other imaging technologies. This diagnostic approach is expected to have a significant impact on diagnostic imaging when used in combination with compact medical imaging devices.

No Innovation without Equality

In the past, collaboration between industry and academia has generally involved concepts formulated at universities being developed into marketable products by companies. However, in the CK Project, all concerned parties thoroughly debate the actual challenges to be undertaken from the outset. As early as the concept formulation and idea extraction phases, project members from both Kyoto University and Canon have exchanged opinions on a level footing. The above-mentioned six primary research topics are a direct product of this close relationship.

The various opinions provided by physicians working in clinical fields at Kyoto University are extremely valuable in terms of the development of Canon's next generation of modalities. Meanwhile, Kyoto University has received much stimulus from Canon's leading-edge development expertise used to convert innovative new technologies realized through collaborative efforts into actual system products.

World Leader in Medical Imaging

In previous years, Europe and the United States have generally taken the lead in developing modalities applying technologies such as X-ray CT and MRI. On a global level, major foreign manufacturers hold large shares in the market for medical devices, making it very difficult for newcomers to gain a foothold.

However, the rapid advancement of information technology in recent years has ushered in an era of change in this market. As the shockwave of technological innovation spreads under the force of advances in computer science, manufacturers have an opportunity to introduce new modalities into the market. Meanwhile, the market for medical imaging solutions retains significant growth potential, especially given societal factors such as intensifying demand for better quality of life (QOL) and the combination of low birth rates and an ageing population in Japan and other countries.

Japan is not the only market for medical treatment solutions. The market extends not only to Asia, but also the rest of the world. While continuing to work on industry-academia collaborations with Kyoto University and other centers of learning in Japan, Canon intends to promote the spread of open

Academic Partnerships

Canon is actively pursuing joint R&D projects with universities and research organizations both in Japan and abroad. We are currently working on the CK Project with Kyoto University, and we provide support for the Center for Optical Research and Education (CORE) at Utsunomiya University. Outside of Japan, we have established an optics research facility with the University of Arizona, providing funding and research staff for the venture.

Academic Partnership with Kyoto University

In 2006, Canon and Kyoto University launched the CK Project to conduct research and clinical studies toward the development of a new generation of medical diagnostic devices enabling the early diagnosis of diseases. Researchers from various disciplines work together in the pursuit of clear targets within an organizational structure and support framework to facilitate dedicated R&D activities.

Academic Partnership with Utsunomiya University

CORE is a research and education facility established by Utsunomiya University in 2007 for the training of optical engineers and the pursuit of cutting-edge optical research. As a leading manufacturer in the optics industry, Canon provides support and cooperation, including the sending of company employees to serve to teach lessons on optics, with the aim of making CORE one of the world's premier research and education facilities.

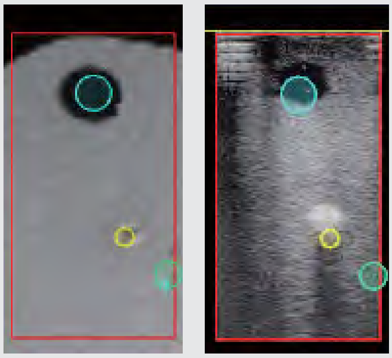
innovation throughout the world. We must ask ourselves which research organizations and corporations we should collaborate with in formulating development strategies and conducting joint research. In the field of medical imaging, Canon is making open innovation a reality one step at a time.

Medical Imaging Approach No. 3

Image Fusion

Integration of Multiple Images for Early Detection of Disease

Image fusion is a technology used on image data acquired from multiple diagnostic modalities. It corrects spatial position relationships, including changes in shape, and displays them side-by-side (or using an overlay). Tumors and the like are seen in different ways depending on the modality used, and by simultaneously displaying the images obtained from each with their positions aligned, this technology makes it possible for areas of disease to be found earlier. In addition, it is also hoped that image fusion will reduce the workload of physicians required to study a vast amount of images.



MRI Ultrasound

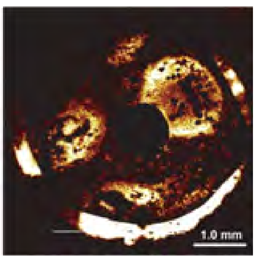
Example of Image Fusion

Canon's Other Visualization Technologies

Digital Mass Microscope

Canon's digital mass microscope technology can be used to visualize the two-dimensional distribution of proteins on a cellular level. We focus on TOF-SIMS* which makes it possible to obtain a two-dimensional mass image of materials with sub-micrometer resolution. Advanced visualization was achieved by adding a proprietary developed ionization-promoting reagent to chemically pretreated proteins. Canon is currently working to develop applications for this technology in pathology and other medical diagnosis, and also to formulate new methods for analyzing cell functions.

* Time-of-Flight Secondary Ion Mass Spectrometry

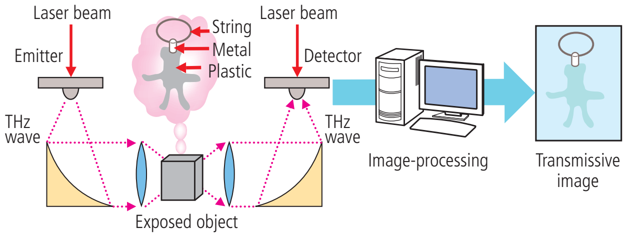


Imaging Mass Spectrometry Image (Example of Use in Functional Pathology Diagnosis of Breast Cancer)

Whereas current methods for functional pathology diagnosis of breast cancer use the antigen-antibody biological reaction to visualize a specific protein, the mass microscope approach makes use of physical and chemical means to simultaneously visualize a number of different proteins.

Terahertz Imaging

Residing between radio waves and visible light in the electromagnetic spectrum, terahertz radiation can pass through objects in the same way as the former but travels in a straight line in the same way as the latter. This electromagnetic radiation can also be put to use in the imaging of the insides of objects, and because of its low photon energy, it is notable for its relatively small effect on the human body. As few emitters or detectors have been developed for practical use, terahertz radiation was often referred to as the unexplored frequency range. At Canon, however, we have successfully developed a compact emitter and tomographic imaging technology based on this electromagnetic radiation. Meanwhile, we are also conducting further research and development with the goal of realizing medical applications and also putting these technologies to work in a wide range of other fields such as in-plant quality inspection and security.

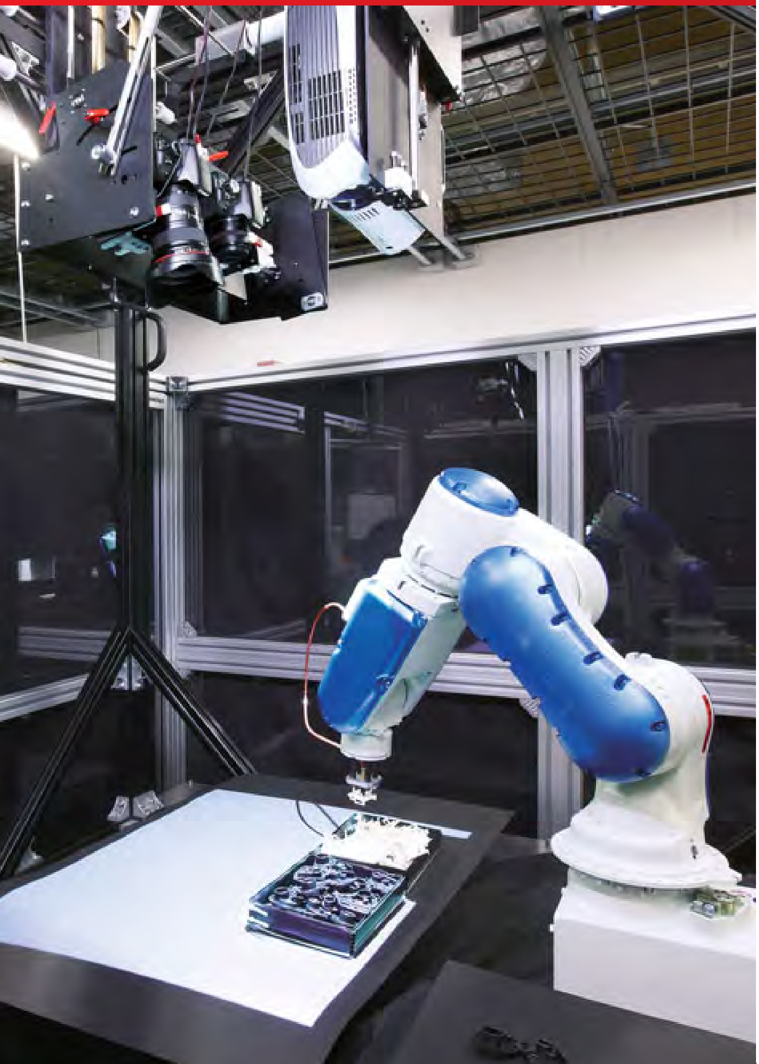


Terahertz Imaging System and Transmissive Image

Having wavelengths between those of radio waves and visible light, terahertz radiation can be used to identify materials such as paper and plastic, producing images that would never be possible with X-rays.

Super Machine Vision

See – Decide – Act. Prepare through learning. Advanced recognition technology breathes life into a new class of intelligent robots. As a further extension of its successful practical application of broad-ranging technologies for facial recognition, character recognition, and image retrieval, Canon is currently engaged in a next-generation project to develop elemental technologies for intelligent robots.



Canon's Approach to Robot Technologies

In Canon's system for producing laser printer toner cartridges (→ P.68), every single process from component supply to final inspection is automated. This approach is also being implemented in the manufacture of ink cartridges, and the company is working to realize totally unmanned production lines and to apply this technology in component assembly and inspection processes for cameras and printers. Canon has put a focus on vision in its approach to robot technologies, and in line with this approach, development of the Intelligent Vision System got underway in 2000. Since then, CMOS sensors and other internally-produced LSI circuits, proprietary image-capture technologies, and original recognition technologies have all been deployed in the quest for a next-generation system.

Intelligent Robot Vision

The Challenge of Developing Super Machine Vision

As humans, whenever we acquire visual information in the form of brightness, color, contrast, texture, structure, and the like, we can, based on experience, instantly analyze that information to determine whether the object we perceive is large or small, an animal or another person, a man or a woman, dangerous or benign, and so on. This type of visual information is, however, generally very voluminous, and highly powerful, high-speed data processing is therefore required in order to analyze and assess this data, and to respond to it in a short period of time.

Leveraging autofocus (AF) technologies accumulated in the development of cameras and business machines and also making best use of the image recognition and data processing technologies employed in face detection and character recognition technologies, Canon is currently hard at work in the pursuit of Super Machine Vision (SMV).

In 2005, the company launched its Robot Vision development project with the aim of making it possible to visually inspect laser printer roller components using robotic vision combining proprietary optics, imaging, and recognition technologies.

Following on from this, the SMV development project is further advancing the associated technologies in order to realize intelligent robot vision that goes beyond the original goals. This enables robots to act beyond their programming, to, in much the same way as a human, autonomously sense changes in conditions around them, make judgments based on these changes, and also learn from acquired experience.

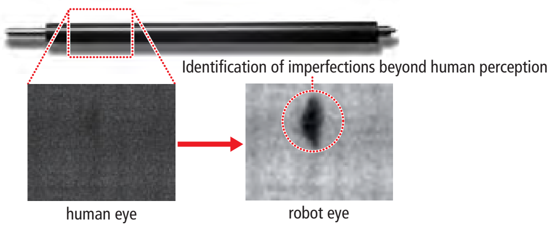
To this end, Canon has taken two approaches to SMV development, focusing on Industrial Machine Vision and Monitoring Machine Vision.

Canon's Previous Successes in Recognition Technology

Visual Inspection of Laser Printer Rollers

Even with the human eye, long periods of training are required in order to detect the tiny surface defects that occur on the surface of laser printer rollers, and to complicate matters even further, these surface defects occur with no set pattern. For this reason, reliable classification of these rollers as acceptable or defective by robots had been close to impossible.

In response, Canon's Robot Vision project set out to develop technologies related to position/pose measurement, 3D imaging, and robot learning to find out optimal illumination conditions for surface defect detection. Thanks to this approach, robot systems became capable of detecting tiny surface defects that the human eye never could.



Inspection of Developing Rollers Using Artificial Vision and Detection

Industrial Machine Vision Using Cutting-EdgeTechnologies

The aim of the Industrial Machine Vision approach is to develop vision systems for automatic production robots used in the assembly and inspection processes for a wide range of company products. Performing the same function as the human eye, the Illumination & Capture Unit employed in these systems incorporates some of Canon's most advanced technologies.

Meanwhile, the Processing Unit that operates as the brain of the system is packed full of recognition and image processing technologies accumulated over the company's long history. In order to realize intelligent learning capabilities, furthermore, the unit's algorithms have been developed in line with Statistical Machine Learning – an approach whereby estimation and learning are made possible through the analysis of statistical data.

The Quest for Intelligent Robots that Can Coexist with Humans

It is Canon's intention to further enhance SMV for industrial machine applications so that it may also be put to use in artificial-intelligence robots.

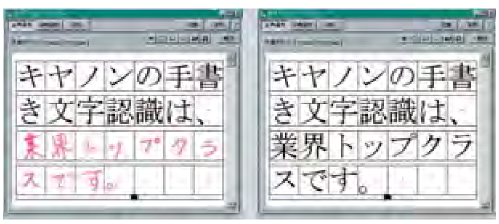
In line with the concept "Safety and Security", the Monitoring Machine Vision approach to SMV aims to realize solutions in a sector of ever-increasing importance – namely, the detection of threats to the safety of children and the elderly and quality-of-life support activities such as rehabilitation assistance and health care. Specifically, the company's monitoring vision systems will recognize and learn the postures, actions, and behavior of persons captured by monitoring cameras, and through the integration of artificial intelligence, it is hoped that this approach can be further advanced to realize the next generation of network cameras.

Canon intends to employ this system in healthcare and livelihood support and many other backup activities that enable people to go about their daily lives with a greater sense of security; furthermore, the company also hopes to continue development towards the realization of a solution where robots could coexist harmoniously with man.

In anticipation of a day when intelligent robots will undertake many active roles in a vibrant society, Canon is fully devoted to the development of Super Machine Vision.

Pattern Recognition Technology

Canon has amassed an impressive wealth of expertise in the recognition technology whether it be face detection, motion detection, or scene detection technologies as used in digital cameras (→ P.29) or the character recognition, speech recognition, or image retrieval technologies as used in business machines (→ P.62). Classed as pattern recognition technologies, these technologies have recently been integrated with Statistical Machine Learning with the aim of developing research with artificial-intelligence applications.



Handwriting Recognition Technology

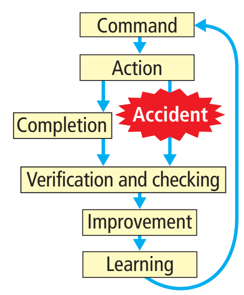
Robot Technology Approach No. 1

Artificial Intelligence Robots

Robots Capable of Learning and Self-Development

Robots used in production plants and the like generally operate based on programs that have to be prepared in advance, and for this reason, they have no means of responding to any changes in conditions around them.

At Canon, however, efforts are underway to develop technologies that will help in the realization of artificial intelligence robots – that is, robots capable of verifying and checking the results of their actions and modifying their behavior in response to feedback and changes in conditions. As such, these remarkable machines will have the intelligence to learn through their own experience.



Even if an accident should occur (as a result of changes in outside conditions), the robot will continue to operate, will then verify and confirm the results of its actions, and will develop by improving its own algorithms and programming.

Recognition Sequence of Artificial Intelligence Robot

Robot Technology Approach No. 2

Conceptualization of Plant SMV

Picking Small Items from a Large Pile

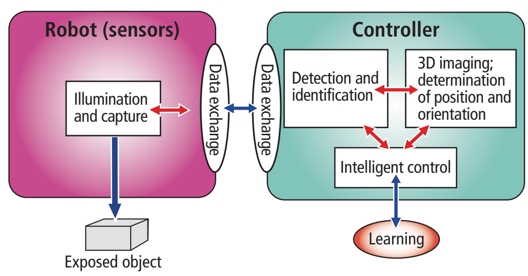
In an SMV system configured according to Industrial Machine Vision, a Global Camera & Illumination System is installed above a work area in order that the position and orientation of components can be accurately determined. Meanwhile, a Local Camera System is mounted on a robot arm to provide the vision functionality required for component assembly. However, as the components that these cameras must identify are often transparent, shiny, or of an achromatic color such as black or white, identification of specific items within large piles has previously been a difficult task. In its development of Industrial Machine Vision, Canon is working to realize an industrial SMV technology capable of supplying and assembling such components with high levels of speed and accuracy.

Robot Technology Approach No. 3

SMV Intelligent Control Modules

Intelligent Robots Built from Elemental Technologies

One of the more distinctive features of Canon's SMV is its 3D-data processing. Specifically, this technology subjects image data acquired by the Illumination & Capture Unit to detection and identification processing in order to quantitatively determine the position and orientation of the objects being observed. In order to achieve this, decision making and overall control are entrusted to an Intelligent Control Module. Furthermore, it is envisaged that future versions of this technology will encapsulate all such functionality in a single module.



Identification Functionality

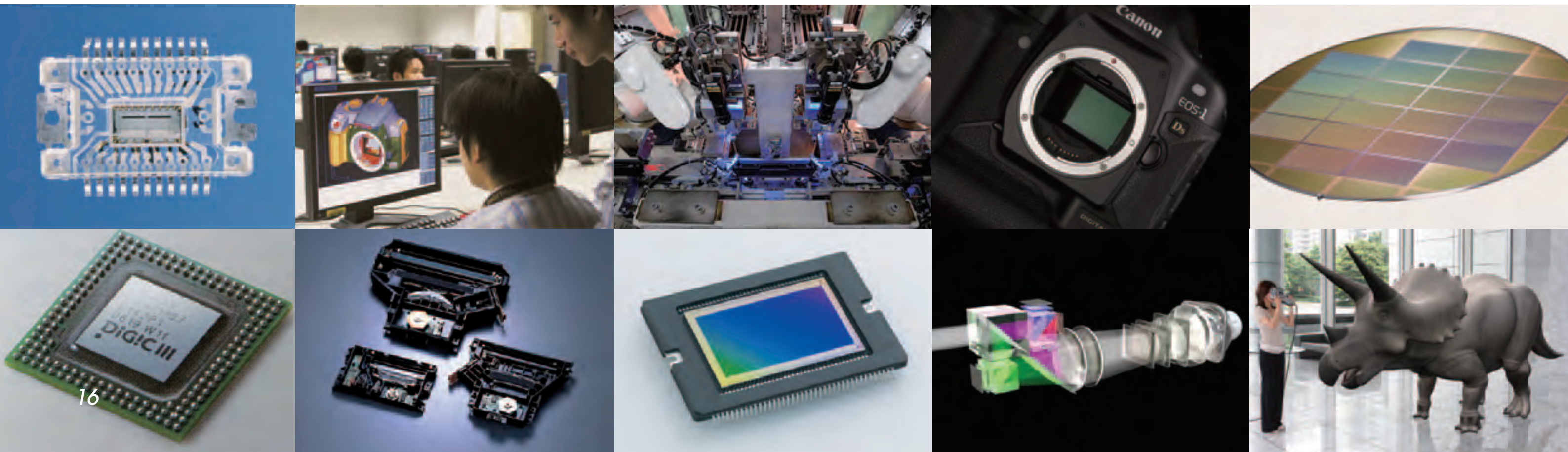
Imaging Pioneering History

Canon's history is a history of embracing technological challenge.
Over the course of many years, in pursuit of the potential of imaging,
the company has conducted research and development into new technologies in various fields,
and grown these technologies to realize new businesses.
The following pages provide an introduction to some of Canon's pioneering
technology-development achievements.

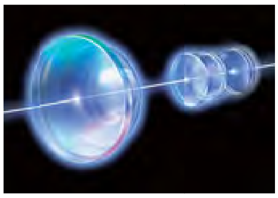
Born of the Dream of Making the World's Best Cameras

In an age in which high-quality cameras from Leica, Contax, and other German manufacturers had become popular, several young Japanese engineers were inspired by the dream of creating their own high-quality camera.

In 1933, they took the first steps on their quest to make this dream a reality by setting up a small laboratory in a room of a rented apartment in Tokyo's Roppongi district. A year later, through a combination of hard work and trial and error, they completed a prototype of the Kwanon camera. It is here that the history of Canon begins.



Optical Technologies that Consistently Produce New Value



The Neverending Challenge of Finding the Ideal Lens

Advanced optical technologies and precision engineering contributed greatly in the quest of Canon's founders to realize their dream of producing the best camera in the world. Of these, optical technologies such as those used in lenses are a combination on a variety of technologies such as lens design, material selection, and processing technologies such as lens grinding and polishing.

The aim of a lens is to form an image of a subject as clearly and accurately as possible, but there is also problem that light does not focus on a single point because the refractive index of the glass varies depending on the wavelength of light. This is called chromatic aberration. Other aberrations include spherical aberration and coma aberration, and it is thus necessary to create lenses by combining concave and convex lenses made of varieties of glass having different wavelength dispersion in order to eliminate aberrations. Lenses are designed using between several and several dozen varied concave and convex lenses combined with over 100 glass materials, but selecting the optimal solution from countless combinations requires not only design know-how, but also an artistic sense similar to that needed to draw a picture. Canon's engineers constantly push the envelope, working hard to accumulate know-how and refine their senses through the design of a variety of lenses.

In order to design superior lenses, engineers must experience designing many lenses themselves, but referencing high quality lenses designed by other engineers is also important. When Canon designs a new lens, it holds an unveiling called a "review" providing an opportunity for information to be shared not only by the engineers responsible for design information, but also many other engineers. The strength of Canon's optical technologies is in the shared experience and accumulation of design information on numerous lenses by engineers.

Canon also developed its own computer software for lens design in the early 1960s, and has been developing a variety of software since. Canon's excellent design tools marks another strength of the company's optical technologies.

The company will continue to proactively undertake challenges in the pursuit of lenses that correct aberrations to the ideal degree.

High-Performance Lens Achieved by Embracing the Impossible

To date, Canon has produced literally hundreds of masterpiece lenses.

One such example is the fluorite lens, which had long been considered impossible to implement practically. Fluorite is characterized by extremely low levels of chromatic aberration, making it ideal for capturing vivid, detailed images that cannot be achieved using conventional optical glass. Fueled therefore by a burning desire to use this material in their lenses, the company's engineers ultimately succeeded in synthesizing fluorite crystals. Canon also developed special processing technologies for such delicate materials, which could not be polished in the same way as normal optical glass, quadrupling the amount of time used during the polishing process. In 1969, Canon launched the world's first lens incorporating fluorite.

However, fluorite is extremely expensive, so Canon developed glass with characteristics such as a refractive index and dispersive properties similar to fluorite in order to correct chromatic aberrations in more lenses. In the late 1970s, Canon succeeded in the practical application of a UD lens using this glass.

The company also began development of aspherical lenses. In theory, with conventional spherical lenses, the focal point for the central portion of the lens does not coincide with the focal point for the peripheral area. This discrepancy, however, can be eliminated with an aspherical lens. Aiming to achieve a level of precision within 0.1 μm (1 μm = one millionth of a meter), Canon engineers repeatedly measured and shaped the lenses, and established the necessary design, processing, and precision measurement technologies. In 1971, Canon became the world's first company to commercially produce an SLR camera lens incorporating aspherical lens elements. Today, the company manufactures aspherical lenses with a degree of processing accuracy of 0.02 μm.

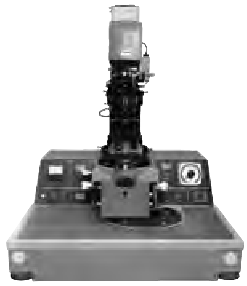
Raw Fluorite, Artificial Crystal, and Lenses

Development of Japan’s First Semiconductor Lithography Tool

In 1965, Canon began to apply its core optical technologies in the development of the U-series of lenses for use in the production of semiconductors. Three years later, these efforts culminated in the U170mmF1.8 – a lens that earned many plaudits for its technical superiority.

As work continued on new U-series lenses, Canon made the decision to expand into the development of semiconductor lithography devices in recognition of the prosperity of the global semiconductor industry. This marked a bold step into an industry of which the company had no previous experience.

Semiconductor integrated circuits are created by taking a circuit pattern drawn on a photomask and optically transferring it onto a wafer. In 1970, the company introduced a semiconductor production lens in the PPC-1 – a 1:1 projection mask aligner for 2-inch wafers that marked the first semiconductor lithography tool to be produced in Japan. However, as the system employed a manual alignment process and 3-inch wafers were to be introduced, this approach advanced no further.



PPC-1: Japan’s First Semiconductor Lithography Tool

Onward to Become an Industry Recognized Producer of Lithography Equipment

In 1974, Canon introduced the PLA-300F, a proximity mask aligner in which the mask and wafer were separated by 10 to 20 μm and exposure was performed using collimated light. This method, capable of processing line widths of approximately 4 μm, facilitated high levels of productivity through its automatic wafer feed capability for wafer sizes up to 3 inches. The company subsequently launched the world's first mask aligner with a laser-based automatic alignment system, the PLA-500FA, in 1977. The machine became a best seller, enabling Canon to make a name for itself, both inside and outside the company, as a producer of semiconductor lithography equipment a mere decade after entering the field.

Subsequently, Canon introduced the MPA-500FA, which used the mirror projection method to achieve high-resolution, 2-μm line-width circuits on wafers of up to 5 inches in diameter, followed by the MPA-600FA, which added support for 6-inch wafers. This model contributed greatly to the mass production of 64 to 256 KB DRAM during the 1980s.

Since 1984, light-source wavelengths have been continually reduced in order to satisfy the need for narrower circuit line widths of semiconductor devices. These wavelengths transitioned from the 436 nm (1 nm = one billionth of a meter) of the mercury lamp g-line, to the 365 nm of the lamp's i-line, the 248 nm of the krypton fluoride laser (KrF laser), and the 193 nm of the argon fluoride laser (ArF laser). Advances were also made in optical systems with the development of new glass materials for light sources giving rise to higher levels of resolution. With these advancements demand grew for improvements in alignment precision, and masks (reticles) and stage control of wafers were also made extremely precise.

In 1984, Canon introduced its first stepper (reduction projection lithography tool) with the FPA-1500FA, which used the g-line as its light source. The FPA-2000i1, which utilized the i-line, was launched in 1990, followed in 1997 by the FPA-3000EX4 – a stepper that employed a Krf excimer laser as its light source. Canon has since gone on to further enhance its line up of lithography equipment.

Canon’s First Stepper, the FPA-1500FA

Patents as a Strategy for Protection & Promotion of Technologies

An oft-heard mantra in Canon's research and development divisions is that instead of reading a paper, one should read a patent; instead of writing a report, write a patent.

Careful study of preceding patents of other companies by engineers and patent specialists not only helps to prevent patent infringements on the part of Canon, but also has a beneficial effect in terms of the company’s own engineering prowess. Meanwhile, the acquisition of as many patents as possible ensures that the company can continue to benefit from technical endeavor while also providing intellectual property for cross-licensing purposes, thus making it possible to enhance the degree of freedom with which design and development can be undertaken.

Canon first setup a specific team to deal with patent-related issues in 1958 with the establishment of the Patent Section within the development-oriented engineering department. Patent strategies were then intensified in the latter half of the 1960s as the company made its first forays into the copying machine market. These strategies played an ever more important role as Canon has striven to diversify, and by ensuring their full deployment in the cornerstone technologies of precision engineering and optics, and also in electronic engineering, recording technologies, system engineering, and communication, the company successfully broadened its horizons.

Realization of World-Class Technologies through Imagination & Perspiration

Electrophotographic Technologies that Defy Conventional Thinking

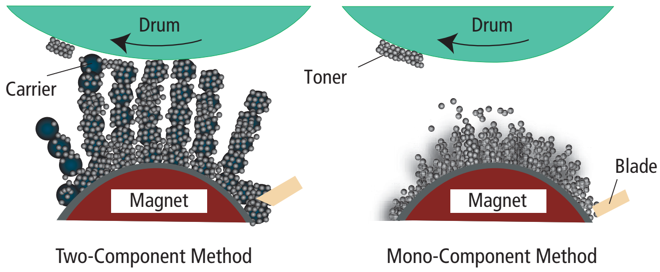
The basic technology behind electrophotography was invented by American physicist Chester F. Carlson in 1938. This was subsequently put to practical use by the U.S.-based Haloid Company (now Xerox Corporation) in the development of the world's first plain-paper copier, introduced in 1959. Since then, electrophotography has gone on to become an important industrial technology employed in a variety of fields.

Canon began its full-fledged efforts in the field in 1962, and three years later, as conflicting technologies competed on a global stage, the company invented its NP approach.

Canon's NP method differed from that of Xerox in that it did not use selenium as the photosensitive material. Instead, it opted for cadmium sulfide (CdS), a camera developer material already in plentiful supply at the company. A hard insulating coating was applied on top of the CdS to create a unique three-layer drum, achieving much higher levels of durability compared with the extremely delicate selenium-coated drums, which required regular maintenance.

In 1979, Canon broke with convention and did away with the concentration adjustment mechanism, essential for the two-component method that had been employed up to that time and made use of a conductive toner and iron powder. In its place, Canon announced the NP-200J, which employed a dry mono-component jumping-development approach. This new method vastly improved the sharpness of copied images by accurately applying an insulating toner with a small particle size of several micrometers, or several millionths of a meter, onto the photosensitive drum. A range of advances and improvements enabled a simplified structure, including the implementation of a new optical system incorporating a Selfoc lens, made possible through the development of a new toner containing an extremely small amount of external additive, and the application of alternating current carrier voltage to the carrier during development, an approach that defied conventional thinking. As a result, it was possible to achieve an extremely compact, low-cost design that enjoyed extraordinary popularity across the world.

Behind this success was Canon's development culture, which wholeheartedly encouraged the tackling of any idea with potential, no matter how challenging it may be.



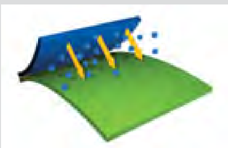
Comparison of the Dry Mono-Component Jumping Method and the Two-Component Method

The Electrophotographic Printing Process

Laser printers, network MFPs, and multifunction production systems all employ the same printing principle.

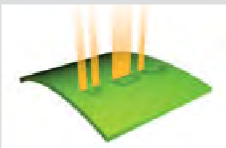
1. Charging

The photosensitive drum surface is negatively charged with a static charge.



2. Exposure

Laser beams scan the photosensitive drum to form an image. Areas exposed to the laser beams lose their electrical charge.

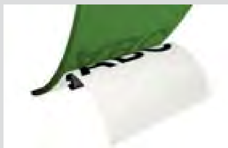


3. Developing

Toner is brought in close proximity to the drum and affixes to non-charged areas.

4. Transfer

The photosensitive drum is brought into contact with the paper* and a positive charge is applied from behind, transferring the toner onto the paper.



5. Fixing

Heat and pressure are applied to fix the toner to the paper.

* Most color models use a transfer system in which the toner first transfers from the photosensitive drum to an intermediate transfer belt, then from the belt to the paper.

All-in-One Toner Cartridge Breakthrough

1982 gave way to a revolutionary breakthrough in the way developers viewed copying machines. Previously, unavoidable regular maintenance made photocopiers seem unsuitable for non-business applications. However, the emergence of the all-in-one toner cartridge concept, enabling the replacement of the toner, drum, and all other major copier components in a single operation, and the development of related technology opened the market for home-use copiers. Canon's PC-10/20 and more advanced Family Copier models have had a major impact on electrophotographic technology, as well as the company's business, from manufacturing to marketing.

Passage of the Inkjet Approach from Concept to Conviction

In the mid-1970s, Canon was among the first to recognize the true potential of inkjet technology, and proceed with the development of this technology. Competition between Canon and a number of printer manufacturers to develop inkjet printing using piezoelectric elements led to Canon introducing a monochrome desktop calculator printer using piezoelectric elements in 1981. However, Canon continued to pursue a more advanced inkjet technology based on a new principle that could surpass printing using piezoelectric elements.

It was around this time that a fortuitous incident occurred. When an engineer was conducting an experiment, the tip of a soldering iron came into contact with a nearby syringe needle containing ink, causing ink droplets to spurt out from the tip of the needle. This was the moment that the idea of using heat became a firm belief. This led to a variety of experiments and tests, which in turn resulted in the creation of a proprietary inkjet technology that uses the heat from a heater to eject ink droplets. On October 3, 1977, Canon submitted a basic patent application for the world's first thermal inkjet (Bubble Jet) technology.

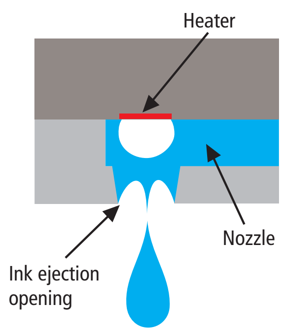
The Soldering Iron and Syringe that Sparked the Invention

Overcoming the Numerous Challenges of Inkjet Printing

There were still, however, many hurdles that remained before this technology could be successfully commercialized, one of which was heater durability. Heaters located inside the microscopic nozzles that eject the ink are formed using semiconductor production technology. Even though moisture and electrolytes are the bane of semiconductor elements, Canon challenged conventional wisdom by bringing ink, which contains both of these elements, into contact with the semiconductor heaters in order to vaporize it. Persistent trial and error eventually led to the development of a thin, high-performance insulation layer that electrically insulated the heater and ink in a highly reliable manner and was also capable of withstanding the powerful shock resulting from the generation and expulsion of bubbles.

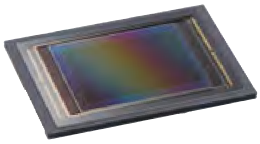
Thermal decomposition of ink components presented another major problem. Heating the surface of the heater to several hundred degrees in one-millionth of a second caused the ink to break down and denature, resulting in the deposition of insoluble sediment. With this process being repeated millions of times inside each nozzle, the efficient transfer of heat eventually became impossible. This phenomenon led to the coining of the term *kogation*—formed by attaching an English suffix to the Japanese word koge, meaning "scorch" or "burn"—an expression that went on to gain international acceptance. While the problem was thought by some to be insurmountable, the company, through the development of new analytic methods and the carrying out of massive amounts of repetitive testing, successfully found a solution to the problem of kogation. In 1985, eight years after submitting the original patent application, Canon launched its first Bubble Jet printer, the BJ-80.

More than twenty years have passed since the introduction of the BJ-80. During that time, inkjet technology has evolved from monochrome to color, from text-centric output to graphics, and finally to photo-quality printout. Achieving photo-quality printing demanded smaller ink droplets, a goal that posed multiple challenges. Of primary importance is the technology that makes possible the high-precision creation of several thousand nozzles. There are, however, limits to the degree of accuracy with which several thousand nozzles can be assembled. Canon wasted no time in precisely identifying these limitations, and in 1992, initiated ambitious efforts to devise a revolutionary new production technology. Making full use of its original materials technologies and also of photolithographic technologies employed in the production of semiconductors, the company successfully developed the world's first production method for highly accurate nozzles that did not rely on the bonding of separate components. Using light to create the nozzles, this groundbreaking technology was christened FINE (→P.36). Over the next seven years, it was carefully perfected before being market launched in 1999 as part of the BJC-8500. Offering outstanding image quality, it marked a new chapter in the development of inkjet printers.



The FINE Nozzle

Advancing Technologies for the Digital Revolution



Successful Development of the CMOS Sensor Driven by Belief in its Potential

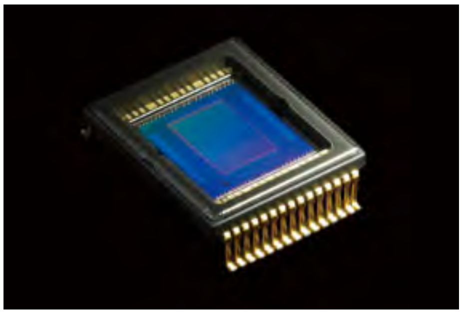
In 1987, during the analog camera era, Canon developed the BASIS bipolar amplification sensor as the focusing sensor for the EOS650, its first autofocus SLR camera. Recognizing the potential of this sensor, the company's engineers embarked upon a detailed analysis and enhancement project marking the start of the CMOS sensor.

Subsequently, Canon decided to use the CMOS sensor the company developed in-house as the image sensor in the digital SLR camera planned for release in 2000. At the time, imaging elements in digital SLR cameras requiring high image quality and high sensitivity were primarily CCDs, and the incorporation of a CMOS sensor was revolutionary.

Compared with CCD image sensors, although CMOS sensors generally offered the advantages of low power consumption, fast reading speeds, and low cost, their high levels of noise and poor sensitivity were pointed out as disadvantages at the time. To overcome these shortcomings, the company thoroughly reviewed all processes required for manufacture and developed a 4-transistor pixel structure and a correlated double sampling noise-cancellation system, thereby successfully reducing noise.

Meanwhile, it also became necessary to produce clean transistors with a leak current approximately 1/1,000th of that of transistors used in standard PCs and memory elements. Leaking of current is caused by heavy-metal contamination during the manufacturing process and irregularities in the structure of silicon crystals; however, the establishment of thorough cleaning and processing technologies for the removal of metal contamination paved the way for the launch of the EOS D30.

Today, CMOS sensors have grown to be large 36 x 24 mm semiconductor elements with a full-frame size of 35 mm. With a pixel count of more than 20 million, CMOS sensors are installed in the company's digital SLR cameras. Canon has also successfully developed a CMOS sensor with 120 million pixels. Moreover, the company has realized further advances in CMOS sensors to make possible a compact video camcorder sensor only several millimeters in size capable of capturing full high-definition (HD) video.



HD Video Camcorder CMOS Sensor

Breaking New Ground: The DIGIC Image Processor

If the image sensor of a digital camera acts like film, then the device responsible for the development process that creates a visible image is the image processor. By the mid-1990s, digital cameras of other companies commonly used a microcomputer, which required several seconds per shot. Canon, in contrast, initially employed the LSI (large-scale integrated circuit) used in video camcorders to process video signals with a new additional LSI; however, there were numerous problems in this approach related to development workload and other factors. Then, in 1996, a project was launched with the aim of developing a single-chip system LSI for image processing, even though there were no formal plans for an actual digital camera product.

While microcomputers utilized von Neumann architecture for sequential processing, Canon adopted a different approach from the very beginning, instead choosing to utilize a unique architecture perfectly suited to all-purpose image processing. In addition, the project was likely the world's first to begin development using a C programming language, enabling rapid, high-quality verification.

One of the most important development objectives for the project was beautiful image quality without sacrificing processing speed. Compromises such as exploiting low expectations for the image quality of digital cameras or assuming that waiting several seconds for each shot was unavoidable were never considered.

1999 saw Canon's first image processor within an actual product, and in 2003, the third-generation image processor known as DIGIC was born. And then in 2008, the company unveiled the ground-breaking DIGIC 4 image processor, offering enhanced face detection functionality capable of identifying faces in the picture frame and determining the optimal focus setting, functionality for correcting brightness and color by automatically identifying the type of scene, high-speed intelligent contrast, and improved video functionality.

DIGIC 4 Image Processor

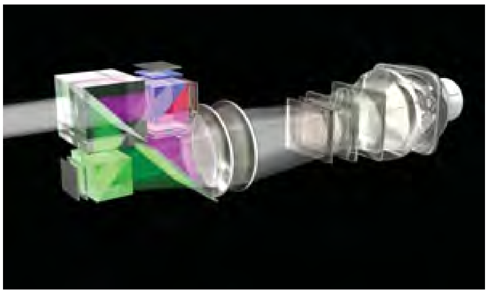
AISYS for More-Compact Liquid Crystal Projectors with Exceptional Image Quality

In 2004, Canon introduced a new optical technology for its liquid crystal projectors. At the time, many conventional projectors used transmissive liquid crystal panels, which produced a lattice-like grid pattern due to the drive circuits between the pixels. In line with its emphasis on image quality, Canon made use of Liquid Crystal On Silicon (LCOS) reflective liquid crystal panels supporting high resolutions, which seamlessly blend individual pixels together to produce an image.

In order to simultaneously achieve size reductions and brighter images with LCOS, however, it would have been necessary to sacrifice contrast. Canon set about resolving the problem, resulting in the birth of the unique AISYS (Aspectual Illumination System) optical system, which makes independent use of the vertical and horizontal directions of light from the light source used to illuminate the LCOS panel.

The first generation of AISYS, which was developed in 2004, succeeded in improving contrast by controlling light converging from the light source independently in the vertical and horizontal directions. At the same time, new color separation/combination and projection lenses were developed, making possible the realization of compact liquid crystal projectors capable of delivering bright images with high levels of contrast and excellent gradation characteristics. In 2006, Canon developed the second-generation of AISYS, which targeted improved illumination efficiency and high-grade image brightness. This succeeded in achieving both high levels of brightness and contrast while also realizing illumination uniformity.

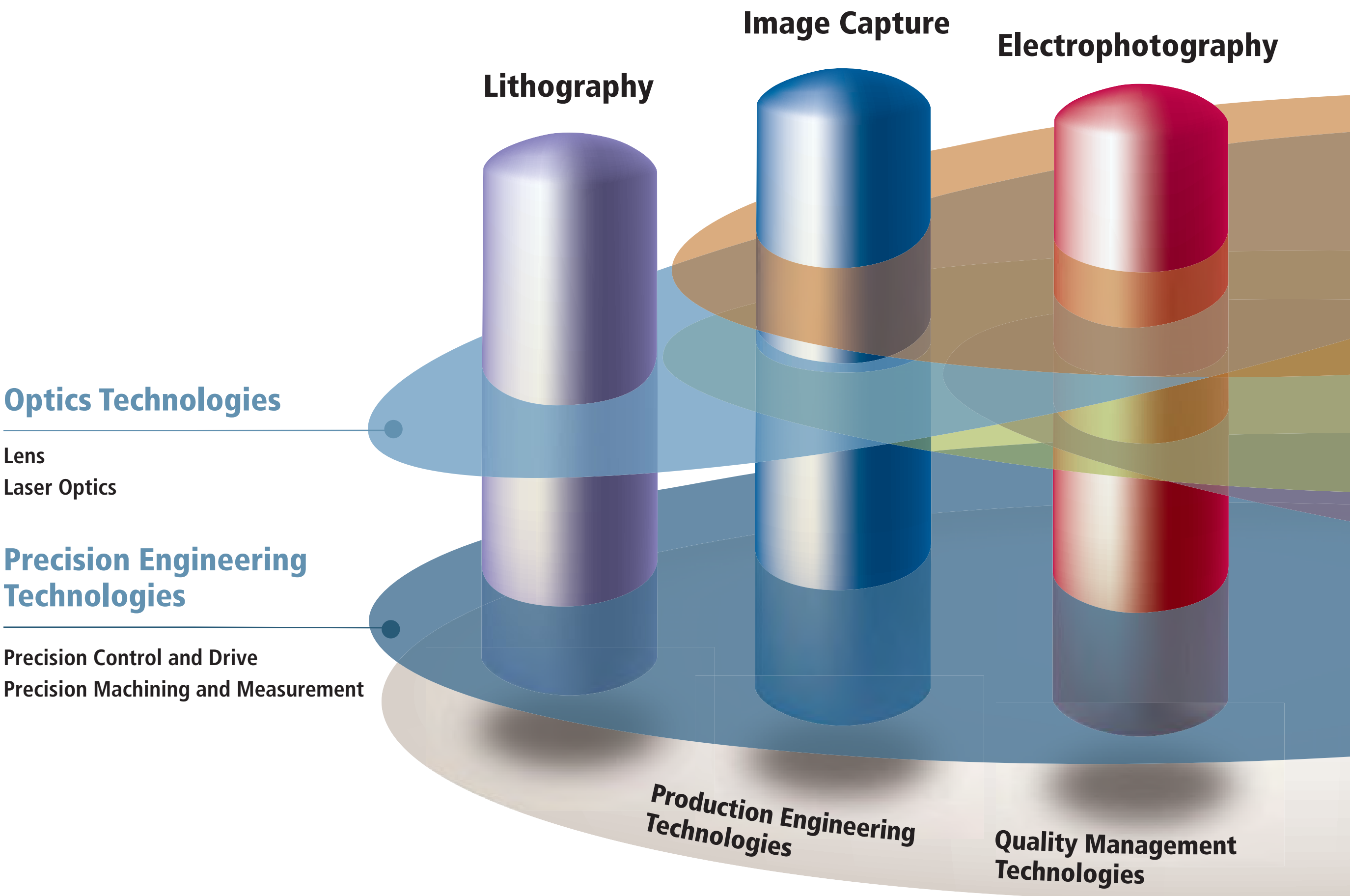
The third generation AISYS of 2008 combines elements such as a fly-eye lens and a projection lamp with superior color rendering performance in order to achieve best-in-class brightness levels using a compact, low-cost illumination system. The image quality of Canon liquid crystal projectors has benefited greatly from this development work.



Third-Generation AISYS

Technology Relationship Diagram

To date, Canon has applied itself to the research and development of a broad spectrum of technologies. This diagram illustrates the relationships between the core technologies for Canon products – namely, image capture, electrophotography, inkjet printing, lithography, and display – and common platform technologies such as digital processing, production engineering, quality management, and environmental technologies.



Development of MR Technology Merging the Real with the Virtual and High-Image-Quality Displays

Mixed Reality (MR) is an imaging technology that seamlessly integrates the real and virtual worlds in real time.

In 1993, Canon applied for a patent for the proprietary freeform prism it had developed, and announced a head-mounted display (HMD) utilizing the freeform prism around three years later. The research and development conducted on optical technology and 3D image processing caught the eye of the Ministry of International Trade and Industry (now Ministry of Economy, Trade and Industry).

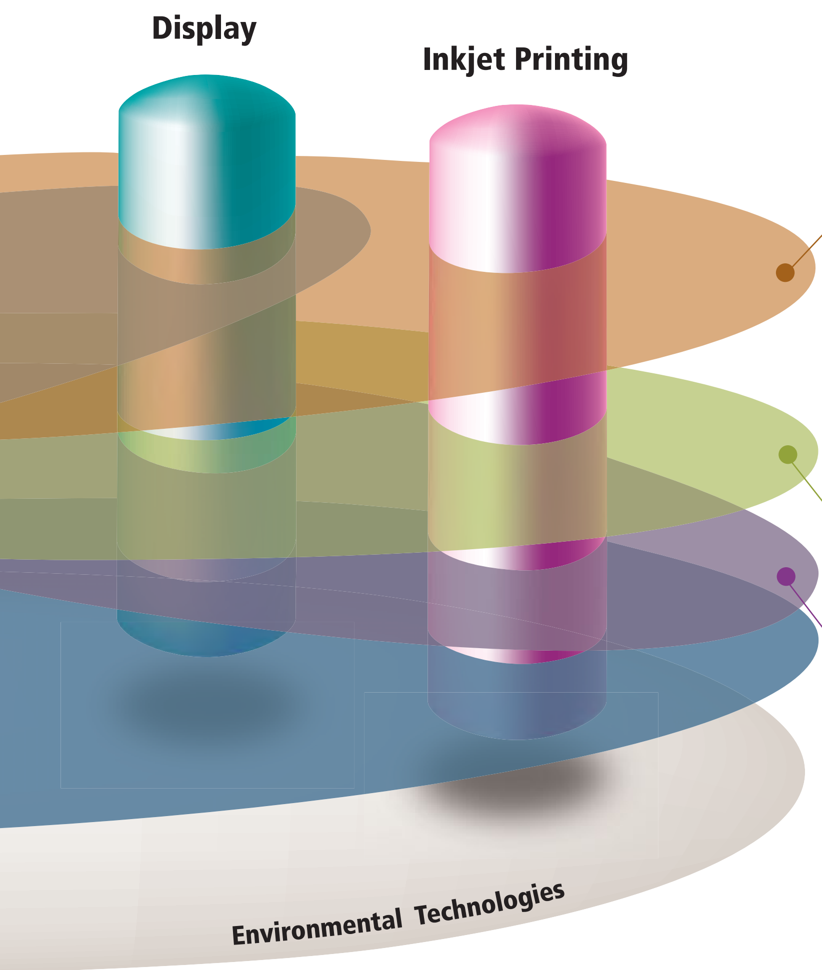
In 1997, Canon jointly founded Mixed Reality Systems Laboratory Inc. with the Japan Key Technology Center at MITI, and began research on MR technology. The Mixed Reality Systems Laboratory conducted research on augmented reality (AR) technology overlaying real space with virtual data and augmented virtuality (AV) technology incorporating the reality of the real world into virtual space.

The Mixed Reality Systems Laboratory was dissolved when the scheduled research period ended, and since April 2001, Canon has carried on with R&D on MR technology. The direction of research has been focused on AR technology since 2004, and applied development aimed at applications in Canon products is currently underway.

Meanwhile, input devices such as digital cameras and digital video camcorders gaining greater functionality and higher performance, and the advancements made in computer graphics (CG) technology have made possible new and unprecedented means of expression through images. This has consequently led to a need for higher levels of image quality in displays outputting images.

In order to address this need, Canon is moving forward with the development of Surface-conduction Electron-emitter Display (SED) technology. SED is a type of display that features low power consumption coupled with high levels of contrast and video responsiveness. Canon is working on a number of different development projects aimed at further enhancing this display's component technologies, such as analysis of electron emitters with nanolevel structures, materials research, and investigation in the fields of drive circuits and panel manufacturing technologies.

Canon is also pushing forward with development on organic light emitting displays (OLED), a display which is characteristically best suited to mobile devices. By independently developing organic materials such as RGB light-emitting materials and electron injection transport materials, Canon managed to achieve high levels of efficiency, color purity and longevity through its prototype panels. Canon aims to realize high levels of performance and low costs by carrying out the entire development process in-house, from devices to processes.



Digital Processing Technologies

System Integration

Intelligent Processing
- Security
- Document Processing
- Automatic Image Correction
- Recognition
- Search
- User Interface

Connectivity
- Internet Applications
- Networking
- Image Transfer

Controller
- System LSI
- Embedded Operating Systems

Image Quality Enhancement
- Color Management
- Image Processing

Simulation Technologies

Analysis Technologies

Materials Technologies

Canon—delivering new value by expanding the boundaries of its unique technologies

Toshiaki Ikoma
Executive Vice President & CTO
Canon Inc.

Opening up new frontiers for imaging

Significant technological prowess underpins Canon's growth potential. Canon possesses the major strengths of optics and precision engineering technologies, and in the field of IT as well, the company boasts advanced technologies in the areas of LSI design, image processing. You could also say that Canon's strengths include the technological disciplines such as materials, simulation, analysis, and software.

Thanks to a sturdy foundation in these fundamentals, the company has successfully developed powerful and reputable technologies for cameras, electrophotography solutions, inkjet printers, and a broad spectrum of other products that to this day, continue to benefit our business.

One of Canon's many talents is an ability to create products that blend and integrate technologies. In terms of electrophotography and inkjet printing, technologies can only be realized through the subtle modification of various technologies, the incorporation of resourceful ideas from engineers, and development efforts that skillfully blend these elements. While most of these technologies are analog in nature, they would not have been possible without many years of practical experience and a wealth of knowledge and expertise. As such, they cannot easily be replicated by competitors.

Nevertheless, given that the creation of new business pillars is one of our principal aims, it is therefore vital that our R&D division boosts the company's technological prowess. It should also be noted that, by introducing new technologies into existing business areas, it is possible to bring about technological innovations capable of causing sudden changes in market conditions that can, in turn, generate new business as a result. As such, it is essential for us to continually develop and enhance our technological capabilities.

Here at Canon, we are currently implementing our cross-media imaging strategy, the ultimate aim of which is to deliver new value to society by continually enhancing tie-ups and collaborative projects that, while focusing on imaging technologies, also extend as far as individual products and business units. While expanding our existing sphere of engineering proficiency and leveraging our strengths therein, we strive to open up broad new fields of imaging application. This strategy is of great importance in continuing to develop Canon's technological strength into the future.

Development of distinctive, uniquely Canon technologies

Technology lies at the very heart of Canon's business, and the technological strengths of this company are many. Going forward, however, we must strive to expand in terms of depth and breadth the technological domains that have come to define our core capabilities—domains symbolizing the strengths that we have cultivated over many years.

Taking optics as an example, technological expansion could take the form of expanding the range of wavelengths handled to include infrared and ultraviolet light in addition to the visible light spectrum. Meanwhile, adding depth refers to incorporating as many varied technologies as possible within a given technological domain. When a fundamental technology increases in terms of breadth and depth, a succession of new technologies will sprout one after the other like bamboo shoots in a bamboo grove.

With these expanded and deepened fundamental technologies providing a foundation, products can be developed into new business pillars. It is in this way that I would like to see us create distinctive, uniquely Canon technologies.

Outlining our medium- to long-term vision in technology maps

In order to ensure that no technologies necessary for future business are overlooked, Canon has drawn up a pair of technology maps—namely, a technology overview map and a technology road map.

The purpose of the technology overview map is to clearly define the technologies that make up each domain. Again using optics as an example, a list of all necessary technologies (themes)—such as those for lenses, materials, assembly, image-capture, and data processing—is drawn up so that an overall view can be easily obtained. From this list, those technologies required by Canon are extracted and displayed on the map in terms of so-called spatial axes.

The road map adds a time axis to the technologies listed on the overview map. By providing a view of how device functionality is expected to develop in the future, of what types of technology will become necessary, and of how academic societies, competitors, and other concerned parties are likely to behave, it paints a picture of Canon's future plans for technologies and product plans within various business domains.

It is important that our medium- to long-term R&D be carried out with a clear overview of the entire technological landscape. Using these two maps, we can determine our technological themes employing a long-term time-based axis, with an extremely broad spatial-axis vision. In this way, anything that we may currently lack, as well as development themes that we should next undertake, become apparent, which allows us to identify all of the necessary R&D conditions. Going forward, we will continue to advance research and development activities from a broader medium- to long-term perspective.

Focus areas of new business and the promise thereof

As technological innovation continues at a rapid pace, it is important to target markets with considerable potential for growth when selecting new fields of business into which to expand. And focusing on business fields in which we can make maximum use of our core capabilities is a key point. In this regard, we have currently identified three promising new business fields—namely, medical imaging (→P.10), intelligent industrial robots, and security & safety.

An example in the field of medical imaging is the development of non-X-ray mammography procedures for breast cancer screening that enable reduced patient stress. Furthermore, we are developing a diagnostic imaging support system that will facilitate accurate diagnoses without the high degree of image-reading experience and skill required for medical imaging approaches in use today.

In the field of robotics, we aim to develop intelligent industrial-use robots utilizing our manufacturing technologies, of which we are proud. By "intelligent robot," I mean robots capable of discerning changes in the surrounding environment and, like humans, learning from these changes, making cognitive decisions, and modifying behavior accordingly. In order to make this a reality, we are currently developing Super Machine Vision (→P.14).

Security & safety represents another area in which Super Machine Vision can be applied. Making use of the imaging technologies in which Canon excels while also drawing upon other advanced technologies, such as three-dimensional measuring and image processing, we are making steady progress in the development of robots and systems for monitoring applications.

Open Innovation

In the past, Canon stuck to using original technologies in the development of products, and this approach has been seen as one of the company's strengths. Going forward, however, we must go beyond self-sufficiency rooted in proprietary technology in favor of Open Innovation-a process whereby multiple companies and research organizations share their unique technological strengths in order to realize new systems.

Only those players with strong technologies are able to participate in this alliance comprising universities, public research organizations and the like.

In concrete terms, we will gradually open up our thinking, first starting with academic alliances (→P.12). One example is the collaborative project we're working on with Kyoto University in the area of medical imaging. Through the sharing of knowledge with the university regarding the way in which medical imaging can drive advances in medicine, I feel the project has progressed further than originally expected.

I also believe product conception skills play an important role when promoting a more open approach, as it is necessary for the company to reflect its unique character in its product conception and marketing activities. For this reason, we are sending our engineers to the sales front on a trial basis in order for them to learn about marketing.

Going forward, we intend to actively promote Open Innovation, sowing the seeds of as many promising technologies as possible.

What is expected of the engineers of tomorrow

I believe it is important for engineers to polish their specialized skills to the professional level and acquire essential capabilities. They must possess unique skills and their own strengths that set them apart from others. That said, they must also follow global technological developments and current needs, and assess and adjust the skills they have acquired accordingly.

I believe that the basic attitude of the engineer should be characterized by a willingness to study, to contemplate, and to employ ingenuity through continued development efforts towards company-defined goals.

Additionally, it is important that they feel their work to be rewarding, can find meaning in their lives based on their work, and are thus able to achieve self-fulfillment. I would like for all of our engineers to approach development efforts with big dreams and a spirit for challenge.

Canon's corporate DNA includes respect for human dignity, an emphasis on technology, and a spirit of enterprise. These qualities are deeply ingrained in the company and continue to provide new value through the realization of unique and innovative technologies.

Canon will continue to cultivate a diverse range of technologies towards the realization of its technological dreams.

Technical Descriptions

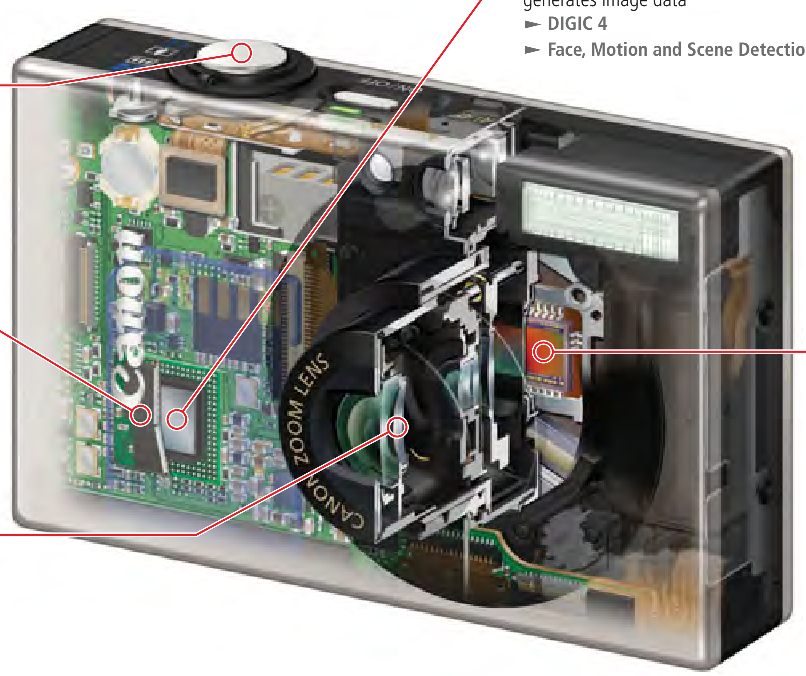
The following pages introduce the various technologies found in Canon products and the many technologies involved in the process of creating Canon products.

Compact Digital Cameras

Canon's compact digital cameras embody the advanced camera technologies Canon has developed over the years and continue to receive enthusiastic reviews from users. Advanced optical technology, camera control technology, and electronic device technology densely mounted in a small body design make for compact cameras that deliver high performance and high image quality.

Overview of Compact Digital Cameras

A compact digital camera is a small camera that uses an image sensor to convert image data into digital signals for storage on a memory card.



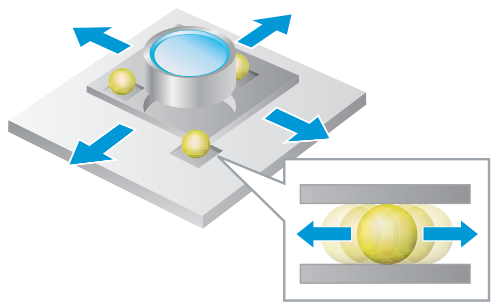
An Ultra-Small Lens Unit with a Lens-Shift Type Image Stabilizer*1

Contributing to a Smaller Camera Body and Higher Image Quality

A variety of technologies are used for image stabilization in digital cameras. The lens-shift type Image Stabilizer (IS) developed by Canon since the 1980s is a typical example. The information detected by a gyro sensor within the camera is used to analyze the amount of movement and shift the lens unit's corrective optical lens to negate this in order to compensate for the bending of light rays from the subject relative to the optical axis.

Canon's compact digital cameras employ lens units incorporating UA lens*2 elements that provide excellent expression while ensuring a compact camera body, and Canon's unique IS technology is used in these ultra-small precision units. The drive mechanism that supports and moves the corrective optical lens employs a ceramic ball support system that features low susceptibility to the effects of magnetism, less thermal deformation than metal and low friction. This works in concert with a high-precision control circuit to provide smooth, precise movement and outstanding responsiveness.

Image stabilization technology has a great effect when used on the telephoto side of a high-magnification zoom lens. However, there is also a growing need for preventing camera shake on the wide-angle side in compact digital cameras with video functions because many scenes are shot with the zoom lens set to the wide-angle side. Canon has developed new technology providing improved image stabilization performance at the wide-angle end when shooting video. Models incorporating this technology enable recording of images with little camera shake compared to conventional models even when shooting while walking.



Ceramic material offers better support than metal because it is less subject to thermal deformation and creates less friction.

Ceramic Ball Support System for Shifting Lens

*1 Lens-shift type Image Stabilizer
Image sensor shift type and electric image processing type stabilization are other image stabilization methods. A lens-shift type image stabilizer has the advantage of providing a wider adjustment scope with almost no deterioration in image quality.

*2 UA lens (Ultra-high refractive index Aspherical lens)
A glass -molded (GMo) aspherical lens with an ultrahigh refractive index.

DIGIC 4

Higher Speed and Further Improved Processing Capabilities

Light entering a digital camera through its lens is converted into electric signals by a CCD/CMOS image sensor. From these signals the digital image processor*3 generates image data with natural color reproduction, rich gradation, and low noise.

DIGIC, Canon's digital camera image processor, is a high performance LSI chip (→P.63) that uses unique architecture to make constant high-speed processing possible.

Using algorithms developed by Canon, DIGIC makes possible the high-speed processing of such tasks as reducing false colors and moiré patterns, and canceling noise during long exposures. It also reduces noise for high-speed image capture and provides higher resolution signal output to the LCD monitor. The processing and memory components are configured in a layered structure to conserve space.

DIGIC 4*4 achieves further improvements in image processing speed. It incorporates the latest features such as noise reduction technology and Scene Detection technology, along with improved video functionality, Face Detection technology, and Motion Detection technology.

DIGIC 4 Image Processor

*3 Image processor
A micro-computer that integrates a CPU, memory to house processing programs, a timer function, and input/output onto a single integrated circuit.

*4 DIGIC 4
DIGIC 4 is the latest version of Canon's DIGIC image processor, which is used in Canon's Digital ELPH/IXUS, PowerShot, and EOS-series cameras. DIGIC is a high-performance image processor with functions to process from low-end to high-end, customized to provide the best optimal performance in every individual camera model in which it is used.

Face, Motion and Scene Detection Technology

In Addition to 3 Core Technologies for Detecting Faces, Motion and Shooting Conditions, Flash Control Technology has been Improved

DIGIC 4 incorporates a variety of technologies enabling easy shooting of optimal photos in any kind of scene. One of these is Face Detection technology, which can recognize human faces in a picture and adjust such factors as focus and exposure accordingly. By combining a Face Detection algorithm that stores the features of people's faces with Canon's own Face Detection algorithm and iSAPS technology,*5 it is possible to quickly determine the main subject of the photo (up to 35 faces in a frame, of which up to 9 can be tracked).

Furthermore, the subject often moves when being photographed. Motion Detection technology determines whether or not the subject is moving, immediately detects the speed and direction of movement, and limits the blurring of the subject by selecting the optimal ISO sensitivity, shutter speed and f/ number (aperture). DIGIC 4 also incorporates Scene Detection technology for determining the type of scene being shot based on a comprehensive set of information including brightness and contrast of the subject, distance to the subject and color of the entire image. Up to 22 types of scene can be automatically identified simply by pointing the camera at the subject, and the brightness and color are adjusted to the optimal levels for the scene.

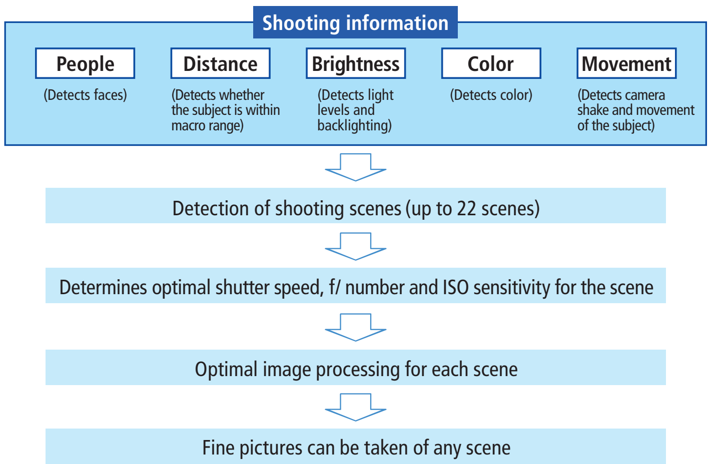
● Smart Flash Exposure Effective in Backlit and Dark Scenes

Based on these 3 core image recognition technologies, improvements have been made to flash control technology called Smart Flash Exposure. The camera automatically controls a comprehensive range of variables such as the amount of light emitted, shutter speed, aperture and ISO sensitivity under backlit or dark conditions. When there is a difference in the distance to the subject and the background in a dark room, this provides a balanced image by brightening the background and preventing blown highlights on the subject. It also utilizes the flash to reduce the shadows shown on people's faces in bright weather, and enables shooting such as "daylight sync" by using the flash to brighten the subject when it is backlit at a distance.

The combination of the latest technologies, such as these three technologies and Smart Flash Exposure, significantly improves the versatility of automatic shooting by enabling automatic shooting with settings optimized for each scene and enabling users to take beautiful photos even in difficult scenes such as backlit scenes and night scenes.

Without Smart Flash Exposure　With Smart Flash Exposure

Smart Flash Exposure



Overview of Scene Detection Technology

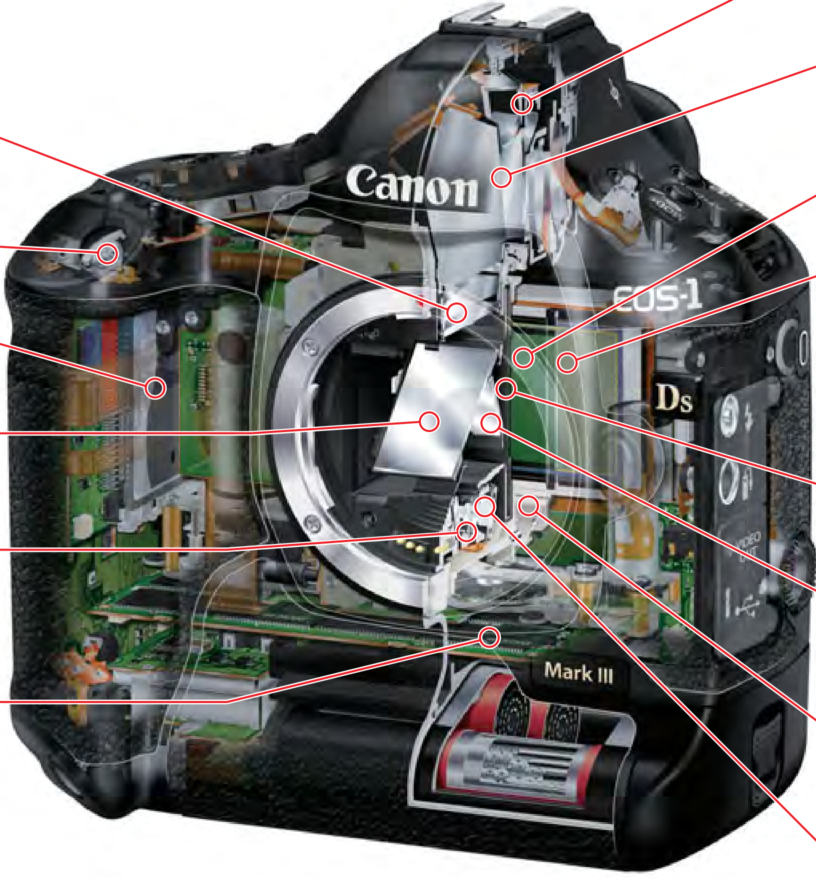
*5 iSAPS technology
intelligent Scene Analysis based on Photographic Space (iSAPS) is a system for rapidly controlling the optimal conditions of the camera by estimating the type of scene being shot by the user based on an enormous photo database accumulated by Canon through its camera development to date.

SLR Cameras

Originally founded as a camera manufacturer, Canon has introduced a series of innovative SLR camera products in its continuing pursuit of the ideal single-lens reflex (SLR) camera. The high-quality images realized by Canon's proprietary and world-renowned lenses, CMOS sensors, and imaging processors are the result of the company's efforts in optical and cutting-edge digital imaging technology.

Overview of SLR Cameras

Digital SLR cameras feature an interchangeable lens system and use an image sensor that converts light into electrical signals to record images.



Focusing Screen
The image of the subject to be photographed is displayed on this screen

Shutter Release Switch

Memory Card

Main Mirror
Flips up during exposure to open a path for light to reach the image sensor

Secondary Image-Formation Lens
Two pairs of integrated aspherical lenses guide the image of the subject to the AF sensor

Image Processor
Processes the signals read from the image sensor at high speeds and generates image data
► DIGIC 4 (→P.29)

Metering Sensor
63-zone metering sensor optimized for Area AF

Pentaprism
Converts the image on the focusing screen to an upright image

Low-Pass Filter

Image Sensor
Utilizes Canon's proprietary CMOS sensor. The image sensor converts light into an electric signal, and is equivalent to film used in a conventional film camera.
► Large Size CMOS Sensor

Shutter
Opens during exposure to allow light to reach the image sensor

Submirror
Elliptical mirror that directs light from the lens to the AF distance-measuring optics

Self-Cleaning Sensor Unit
Removes dust from the sensor surface in the EOS Integrated Cleaning System

Area AF Sensor
► Subject Sensing Technology

Large Size CMOS Sensor

High-Resolution, High-Sensitivity, Low-Noise Image Sensors

The CMOS sensor is a key component of a digital SLR camera. Canon conducts development and production using proprietary technology. Canon currently uses three different sizes of CMOS sensor: 35mm full-frame, APS-H, and APS-C.

Canon's CMOS sensors feature large size and high resolution*1 (Up to approximately 21.1 million pixels with a full-frame 35mm CMOS sensor), excellent sensitivity (low noise) and a wide dynamic range. Featuring eight-channel signal reading and supported by DIGIC, CMOS sensors are capable of achieving high-speed continuous shooting of approximately 10 frames per second and shooting of full HD movies, facilitating new levels of still image and movie expression that far surpass those of film cameras.

Full-Frame CMOS Sensor (Full Scale)

*1 Resolution
The effective number of pixels of CMOS sensors are as follows.

35mm full-frame
EOS-1Ds Mark III/EOS 5D Mark II
  Imaging screen size: Approx. 36 x 24 mm
  Effective number of pixels: Approx. 21.1 million
APS-H size
EOS-1D Mark IV
  Imaging screen size: Approx. 27.9 x 18.6 mm
  Effective number of pixels: Approx. 16.1 million
APS-C size
EOS 7D/EOS REBEL T2i (EOS 550D)
  Imaging screen size: Approx. 22.3 x 14.9 mm
  Effective number of pixels: Approx. 18 million

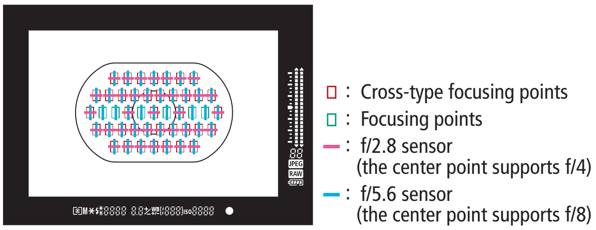
Subject Sensing Technology

Realization of Comfortable and Speedy Shooting Using a System Approaching Eyesight

●New Area Autofocus System

The autofocus system employed in Canon's SLR cameras, which has gained solid support from the market for its speed and ease of use, has continued to develop since the debut of 1-point AF at the center of the viewfinder in 1987. Now this has evolved to the 45-point Area Autofocus with 39 Cross-Type Points, which has markedly increased the number of cross-type points (in which vertical and horizontal line components of the subject are simultaneously detected) from 19 to 39 in the latest high-end model, the EOS-1D Mark IV. All of the cross-type points combine line sensors that conform to f/2.8 and f/5.6 light flux, enabling both detection of the subject and a high level of distance precision.

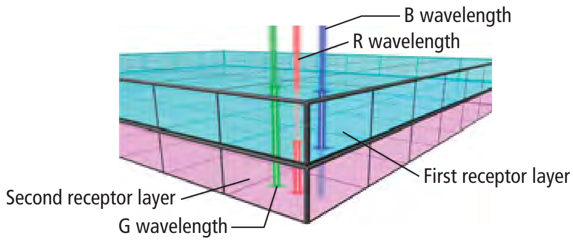
The key device for realizing this new area autofocus system is a high-precision AF sensor newly developed to significantly improve detection capabilities and precision.



Array of Area AF Sensor Focusing Points

●63-zone Dual-layer Metering Sensor

The exposure of the subject is determined by the metering sensor. Canon has developed a new 63-zone Dual-layer Metering Sensor with a dual-layer photo sensor. The first layer measures blue-green light and the second layer measures green-red light. By providing functionality for individually measuring the intensity of red and blue wavelengths of RGB primary colors (color information), this automatically and accurately corrects exposure errors caused by the type of light source. This reflects the actual color of the subject and the changing color information of the subject under artificial light, etc. in exposure to complement the camera's exposure characteristics. This eliminates subtle variations in exposure caused by color. The subject area is also detected based on autofocus information, and stable exposure with emphasis placed on the main subject is achieved through a metering algorithm utilized in computing evaluation metering.



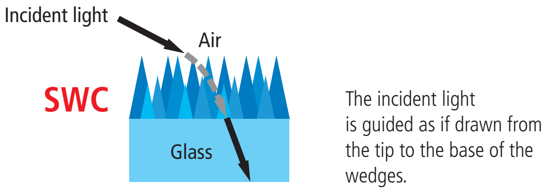
Conceptual View of 63-zone Dual-layer Metering

SWC (Subwavelength Structure Coating)

Lens Coating Technology Created by Nanotechnology

The reflection of light from the lens surface causes flare and ghosting. In the past, the surface was coated with a thin film to control reflected light, but it could not be sufficiently controlled in some cases depending on the angle of incident light.

SWC developed by Canon is a new type of technology for preventing reflection by using an array of countless wedge-shaped nanostructures smaller than the wavelength of visible light arranged on the lens surface to control the reflection of light. As there is a smooth transition between the refractive indexes of glass and air, it is possible to eliminate the boundary between substantially different refractive indexes, which enables significant control over the occurrence of reflected light. It is also very effective with light that has a large angle of incidence, which could not be controlled using conventional coating.



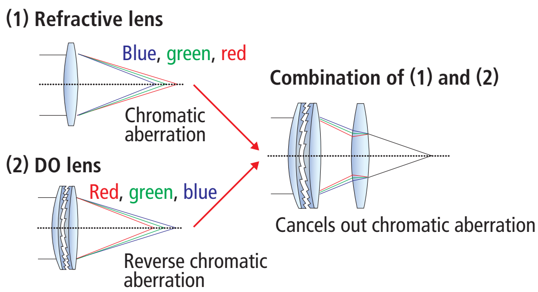
SWC Structure

DO Lens

Realizing Smaller, Lighter Telephoto Lenses

Canon developed the world's first Diffractive Optics (DO) lens to eliminate chromatic aberrations,*2 which occur in opposite directions in diffractive and refractive optical elements. The unique two-layer DO lens takes advantage of this phenomenon, and is formed by placing two precise diffraction gratings a few micrometers*3 apart on the surface of glass lenses to create a multi-layer structure.

Canon incorporated the lens into its EF400mm f/4 DO IS USM interchangeable lens for SLR cameras, significantly reducing the size and weight of telephoto lenses while maintaining their high imaging performance. Next, the company conducted an even more thorough study of the materials and shape of the diffraction gratings, developing a three-layer DO lens that utilizes three diffractive optical elements. Incorporating the three-layer DO lens into the EF70-300mm f/4.5-5.6 DO IS USM zoom lens, Canon also successfully reduced the size of telephoto zoom lenses.



Correcting Chromatic Aberrations with a DO Lens

*2 Chromatic aberration
One factor that can negatively affect image quality is color blur, or chromatic aberration, caused by wavelength-induced fluctuations in the refractive index of light passing through a lens. Ordinarily, this problem is corrected by using multiple convex and concave lenses in combination.

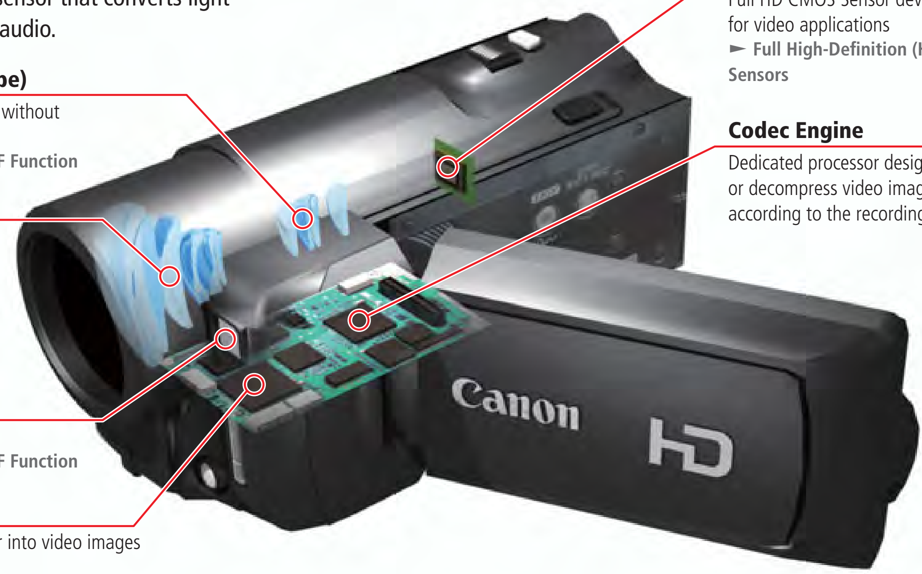
*3 Micrometer (μm) : 1 μm = one millionth of a meter

Digital Video Camcorders

Video camcorders combine video images and audio and therefore require advanced digital imaging technology that differs from that used in photography. Camcorders must process large volumes of data rapidly while also being portable, realizing a compact size and consuming low energy. Applying a range of its advanced technologies, Canon has developed full HD video camcorders to meet the needs of the high-definition era.

Overview of Digital Video Camcorders

A digital video camcorder uses an image sensor that converts light into electrical signals to record video and audio.



Optical Image Stabilizer (Lens-Shift Type)
Designed to counteract the effects of camera shake without sacrificing image quality (Ball support system)
► **HD Video Lens with Image Stabilization and AF Function**

HD Video Lens
An optical zoom lens incorporating aspherical glass lens elements. Uses a gradient ND filter and, in some high-end models, an Ultra high refractive index Aspherical lens (UA lens)
► **HD Video Lens with Image Stabilization and AF Function**

External AF (autofocus) Sensor
Calculates the distance to the subject
► **HD Video Lens with Image Stabilization and AF Function**

Image Processor
Converts electric signals sent from the image sensor into video images
► **DIGIC DV III**

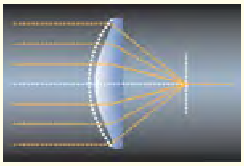
Image Sensor
Full HD CMOS Sensor developed in-house for video applications
► **Full High-Definition (HD) CMOS Sensors**

Codec Engine
Dedicated processor designed to compress or decompress video images and audio according to the recording medium

Image Processing for Video Camcorders

Video camcorders incorporate a camera function, which converts signals of images of the subject into video, and a recorder function, which records and plays back the images from the recording media. Every stage of image processing is supported by proprietary Canon technologies.

Camera Function


Lens
Image formation

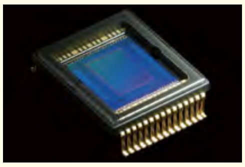


Image sensor
Conversion into signals

Image processor
Image generation

Recorder Function

HD codec engine
Compression/Decompression


Recording media
Recording/Playback

DIGIC DV III

Image Processor for Video Camcorders with Dramatically Improved Processing Speed

DIGIC DV III is Canon's latest image processor for digital video camcorders. With image processing for digital video camcorders, reducing noise*1 is important, particularly in flat and dark areas. Canon's proprietary video image processing algorithms reduce noise and enable the recording of beautiful images with vivid color reproduction and rich gradation.

The latest DIGIC DV III dramatically improves processing speed. It also supports full HD CMOS sensors with large numbers of pixels, providing even higher image quality in video and still images. It also incorporates Face Detection technology (→ P.29), with controls such as face detection AF/AE and face tracking suited for video and photos of people. Furthermore, it supports x.v.Color*2 and offers power savings that are critical for digital video camcorders, contributing to the improved functionality and performance of digital video camcorders.

In addition, the camera control microprocessor that had previously been on a separate chip has been integrated into DIGIC DV III. Processing speed has been increased through various technologies including Canon's unique architecture for creating ultra-large LSIs.

DIGIC DV III Image Processor

*1 Video noise
Random noise is more noticeable in video than in still images and occurs more frequently when shooting in dark conditions. Remedying noise in video camcorders requires a different approach than still cameras.

*2 x.v.Color
Refers to the xvYCC international standard for the color space used in video. xvYCC supports a larger color space than conventional sRGB, and the x.v.Color mark is shown on compliant products.

HD Video Lenses with Image Stabilization and AF Function

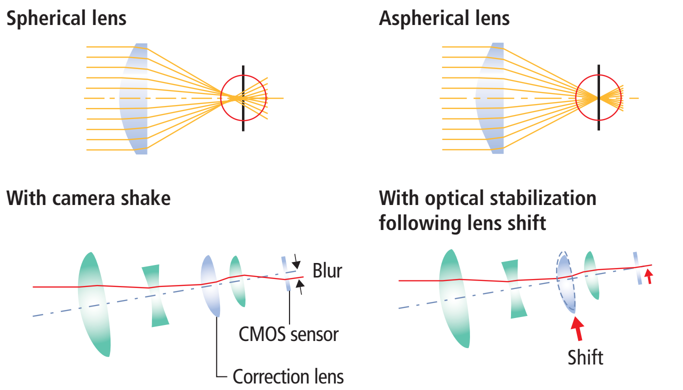
Supporting High-Definition Images

Full HD-compatible lenses require a high level of resolving power. Canon utilizes glass aspherical lens elements*3 in the lens system, optimizing the position and shape of the elements to achieve the best possible lens configuration for HD video images.

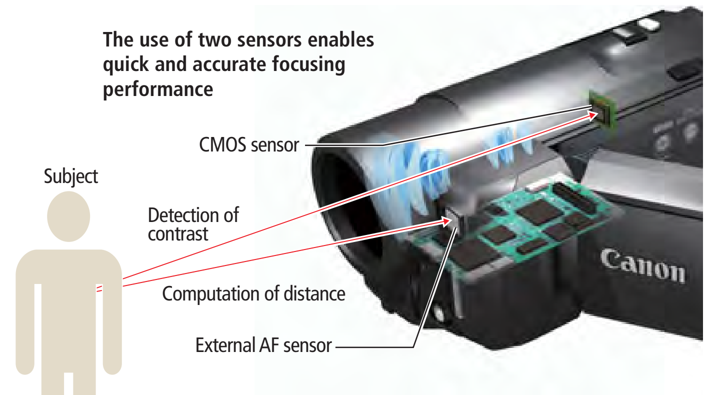
Also, as zoom magnification increases, the effects of camera shake become more pronounced. To counteract this problem Canon employed optical lens-shift image stabilization, which detects a wide range of vibrations, from low to high frequencies, and corrects accordingly. This image stabilizing technology, based on Canon's proprietary lens-shift image stabilizing system, shifts the correcting lens element in parallel to the image plane to correct the optical axis in response to image shake.

As out-of-focus images are easily noticed when shooting HD video, Canon's digital video camcorders incorporate Instant AF functions to provide fast and accurate focus tracking. The system employs an external AF sensor to compute the distance to the subject while detecting the contrast based on the image output from the CMOS sensor to deliver fast and accurate focusing performance. The use of two sensors to focus on the subject enables quick and accurate focusing performance.

*3 Aspherical lens
A lens that is not spherical, but has a curved surface (a surface with a curvature that continually changes in the direction of the lens diameter). While it is difficult for a single spherical lens to converge light sharply at a single point, it is possible with an aspherical lens.



Focal Point Alignment with an Aspherical Lens and Lens-Shift Image Stabilization



Overview of Instant AF

Full High-Definition (HD) CMOS Sensors

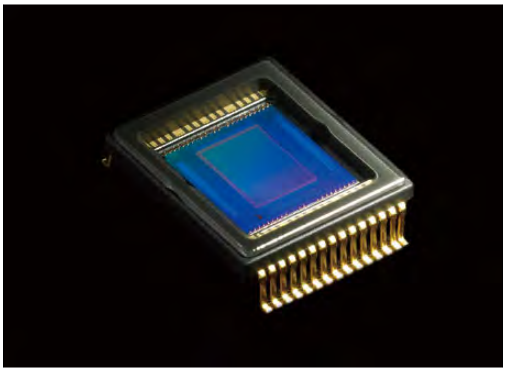
Supporting Full HD with High Speed and Low Power Consumption

The CMOS sensors utilized in Canon digital video camcorders needed to be small because of the compact body of digital video camcorders. The sensor also had to support the reading and recording of high-definition 1,920 x 1,080 pixel resolution (a total of approximately 2.07 million pixels), creating the need to densely mount the pixels on the sensor to realize outstanding HD-quality images.

Adapting the CMOS sensor technology utilized in its digital SLR cameras, Canon succeeded in developing, and is currently producing, a full HD*4 CMOS sensor for video camcorders. The size of the sensor used in the VIXIA HF S21 (LEGRIA HF S21) is 1/2.6, embedding approximately 8.5 million pixels into an extremely small area.

This increase in the number of pixels contributes to improving image quality. The information from approximately 6 million pixels (3,264 x 1,840) read from the CMOS sensor is resized by DIGIC DV III to the 2.07 million pixels required for full HD using Canon's proprietary algorithms. A greater level of original pixel information makes it possible to reproduce images better when resizing, and this is an advantage provided by the CMOS sensor's capability to read large numbers of pixels.

In addition to offering high-speed reading of images in full HD with low power consumption, the CMOS sensor also utilizes a primary color filter featuring comprehensive color information that achieves faithful color reproduction while minimizing false colors and moiré patterns. The CMOS sensor also incorporates On Chip Noise Reduction Technology that supports low-noise recording in low-light conditions on the sensor side, providing high-quality images in combination with DIGIC DV III's signal processing technology for reducing noise.



HD Video Camcorder CMOS Sensor

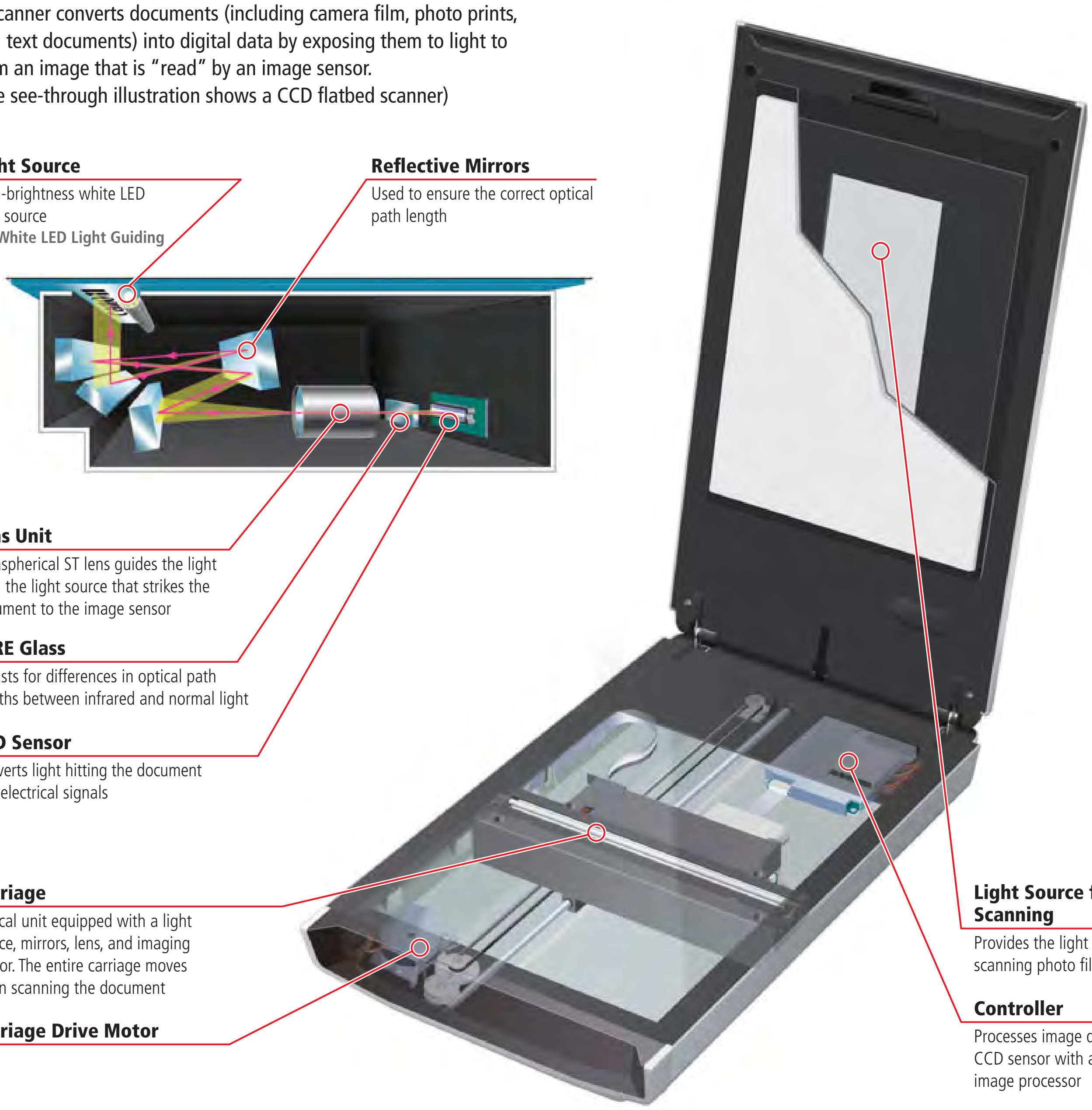
*4 Full HD (compliant)
Digital television signals may be standard-definition (SDTV) with 525 scan lines, the same as analog television, or high-definition (HDTV), with 720 or 1,080 scan lines. Full HD refers to 1,080 scan line systems, which provide the highest level of resolution. With HDTV1080i, the effective number of pixels is 1,920 × 1,080, with 1,440 × 1,080 pixels per frame.

Scanners

Canon has combined many of its advanced optical, electronics, and software technologies to create scanners that enable the conversion of camera film, photo prints, and text documents into high-grade digital data. Canon has worked to develop high-precision scanning technology not only for stand-alone scanners but also for the scanning function of copying machines.

Overview of Scanners

A scanner converts documents (including camera film, photo prints, and text documents) into digital data by exposing them to light to form an image that is "read" by an image sensor.
(The see-through illustration shows a CCD flatbed scanner)



Light Source
High-brightness white LED light source
► **White LED Light Guiding**

Reflective Mirrors
Used to ensure the correct optical path length

Lens Unit
An aspherical ST lens guides the light from the light source that strikes the document to the image sensor

FARE Glass
Adjusts for differences in optical path lengths between infrared and normal light

CCD Sensor
Converts light hitting the document into electrical signals

Carriage
Optical unit equipped with a light source, mirrors, lens, and imaging sensor. The entire carriage moves when scanning the document

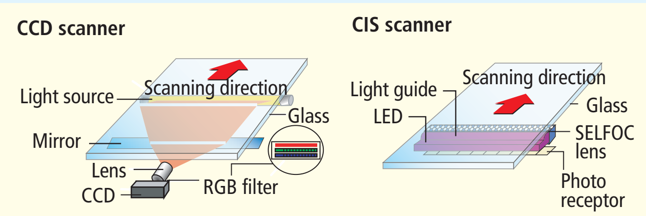
Carriage Drive Motor

Light Source for Film Scanning
Provides the light source when scanning photo film. Uses white LED

Controller
Processes image data from the CCD sensor with a dedicated image processor

CCD and CIS Systems

Canon offers two types of flatbed scanner: CCD and CIS.
CCD models incorporate high-precision optics and high-density CCD line sensors that illuminate the document with a light source such as white LED to deliver sharp, high-resolution images.
CIS scanners are slim-bodied, energy-efficient models that utilize a three-color RGB LED as the light source and read documents with a CIS (Contact Image Sensor) of the same width as document originals.

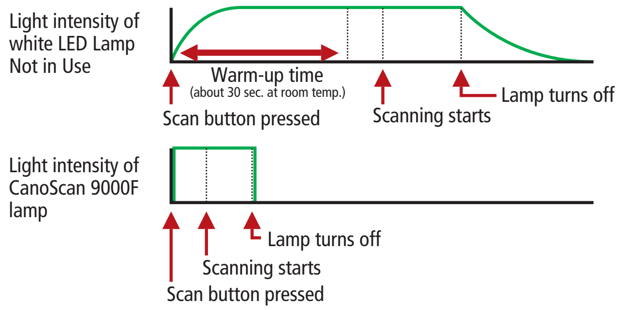


White LED Light Guiding

Enhancing Work Efficiency and Conserving Energy

With conventional CCD scanners that employ fluorescent lamps, about 30 seconds of warm-up time is required after startup or re-activation from sleep mode. While using an LED[*1] as the light source eliminates warm-up time, because it is a point light source, technology is needed to convert it into a linear light source with uniform light intensity.

By applying the LED light guide technology Canon developed for its CIS scanners and researching LED installation and light guide formats, the company was able to develop a high-brightness white LED light source for scanners. This technology ensures stable light intensity immediately upon starting up the scanner, reducing warm-up time to zero. In addition, it is no longer necessary to keep the light on after scanning, which helps save energy.



Reduction of Warm-up Time Through Use of White LED Lamp

*1 LED (Light Emitting Diode)
A semiconductor diode that emits light when an electric current is applied. While LEDs are smaller and lighter than fluorescent lamps, have a longer lifespan, and require less electricity to run, lower light intensity has been cited as a drawback. Recently, as LED brightness has improved, they have been adopted for a wide range of applications.

Image Correction Technology

A Full Array of Image Correction Features for a Variety of Documents

The scanning mechanism is not the only factor that determines scanner performance. The driver that processes data from the scanner and reproduces images is equally important. Canon's ScanGear scanner driver is designed not only to enable exceptional ease of use but also to deliver a wide range of image-processing features. This image-processing technology is based on platform technology used in other Canon digital imaging devices, but has been specially customized for use in scanners.

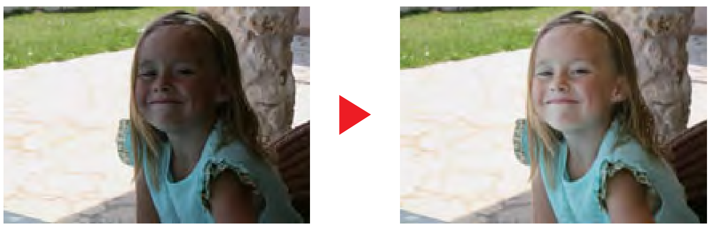
● Dust and Scratch Removal

When scanning photographic film using a high-resolution scanner, minute dust particles and scratches that are invisible to the naked eye are picked up. The dust and scratch removal function first detects dust and scratches with infrared light from an infrared LED, and then determines the size and shape of the dust and scratches along with the characteristics of the surrounding image. Next, the dust and scratches are automatically removed through a high-level integration of hardware and software processing to create a beautiful reproduction.

Before and After Dust and Scratch Removal

● Backlight Correction

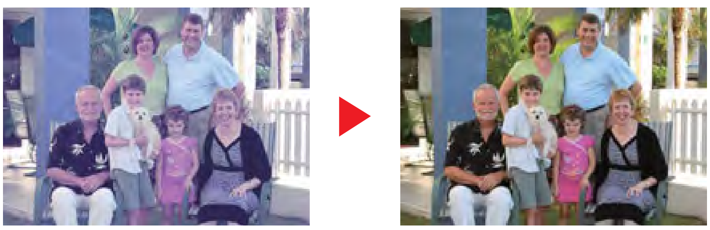
The backlight correction function analyzes backlit images and automatically adjusts the overall image brightness and contrast according to the darkness levels in the areas that need correction.



Before and After Backlight Correction

● Discoloration Correction

The discoloration correction function restores vivid colors to film or photo prints that have faded or display color bleeding. The histogram of the scanned image is analyzed and hue, color balance, contrast, and saturation are automatically adjusted to appropriate levels.



Before and After Discoloration Correction

● Book-Binding Shadow Correction

This corrective function reduces the shadow that occurs when an open book or magazine is scanned. The shadow created by the book's spine is detected using a shape recognition density table, and the brightness is adjusted accordingly.

Before and After Book-Binding Shadow Correction

Inkjet Printers

Inkjet printers enable almost anyone to easily create high-quality photo prints and have significantly changed the way people enjoy photography. An integration of precision technologies, including those for ink and print heads, makes possible the printing of beautiful photographs for users to enjoy in mere moments. Canon's ability to combine component technologies, which it continues to steadily amass, has elevated the quality of inkjet printers to new heights.

Overview of Inkjet Printers

A heater is used to create bubbles in the ink, which cause the ejection of microscopic ink droplets to create an image on paper.

Scanner

Paper Feed Mechanism
Incorporates an automatic duplex print/copy unit, and offers 2-way paper feeding, from either the paper cassette at the front of the machine or rear tray at the back

Ink Tanks
Between four and ten individual ink tanks, one for each color

Carriage
Moves horizontally while the print head ejects ink droplets

FINE (Full-Photolithography Inkjet Nozzle Engineering)

Controlling Microscopic Ink Droplets

After developing the basic mechanisms used in inkjet printers, Canon has continued to foster new ideas and original technologies in the field. FINE is the key technology behind these innovations. FINE's ink ejection mechanism and print head manufacturing technology have enabled Canon to achieve dramatic improvements in image quality, gradation expression, and image stability.

● Ejection Mechanism for Accurate Placement of Microscopic Ink Droplets as Small as 1 Picoliter*1

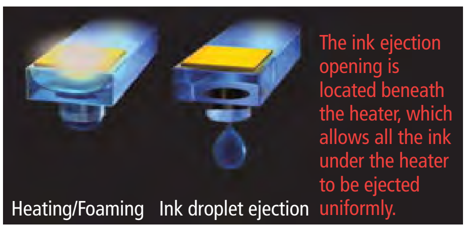
Microscopic ink droplets and precise ejection are essential to high image quality. With conventional ejection systems, however, the finer the ink droplets, the more vulnerable they are to airflow disturbances from print head movement and changes in ink viscosity due to temperature fluctuations, resulting in inconsistent ejection volumes and ink dot placement.

Canon's FINE print head ensures that all the ink under the heater is pushed out in a single ejection to ensure efficient performance. Ink droplet speed has been increased to more than 1.5 times that of conventional systems, reducing their susceptibility to airflow disturbances to enable increased placement accuracy.

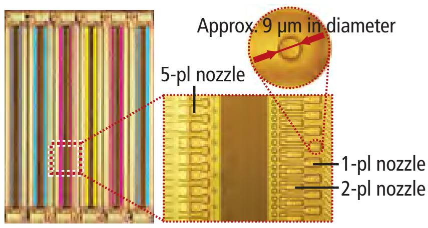
● Print Head Manufacturing Technologies Using Nanoprecision Semiconductor Exposure Equipment

Achieving smaller droplet sizes and faster print speeds requires high-precision fabrication technologies to enable the placement of a greater number of nozzles over a wider area. Canon's FINE print heads are made by integrating the heaters and nozzles into a single unit on a wafer using a process that makes the most of the company's expertise in semiconductor production, as well as its original material technologies and innovative processing technologies. The ability to fabricate nozzles with high precision over large areas without using bonding processes means that 6,000 or more nozzles are arranged within an area measuring a mere 20 mm x 16 mm, roughly the size of a thumbprint.

*1 picoliter (pl) : 1 pl = one trillionth of a liter



FINE's Ink-Ejection Process



Print Head with Enlarged View of Nozzle Configuration

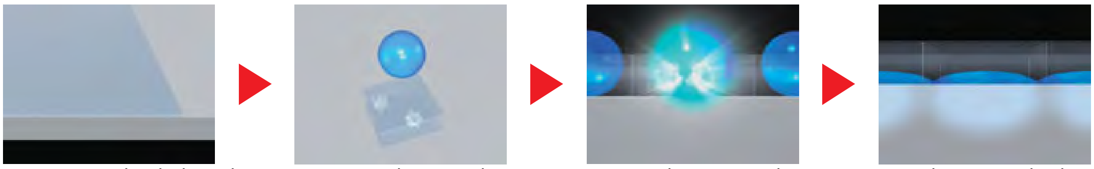
PgR (Pigment Reaction) Technology

Realizing Beautiful Prints on Plain Paper

When printing on plain paper, ink tends to bleed. Canon's PgR technology, however, makes it possible to achieve high-quality print results comparable to brochures and posters, even when using ordinary plain paper. This technology employs newly developed "clear ink" to coat plain paper, after which Canon LUCIA pigment inks[*2] are used to print on the clear ink coating to create high-quality prints.

Canon's clear ink, a transparent ink containing polyvalent metal ions, reacts with the pigment in the pigment ink, causing it to bond with the surface of the paper. In order to establish PgR technology, Canon redesigned its ink materials and developed new mechanical devices such as rollers to spread a thin, uniform layer of clear ink over the surface of the paper.

*2 Pigment ink
A type of ink that uses micro-dispersion of extremely fine pigment particles and achieves superior longevity.



The paper is coated with clear ink. | Pigment ink is ejected. | Upon contact, the pigment ink reacts with the surface of the paper. | Improved saturation, brightness and ink fixation.

PgR Technology Ink Fixing Process

ChromaLife100+

Long-Lasting Beauty of Photos

ChromaLife100+ is an advanced system for preserving the beauty of photos that combines Canon's genuine dye inks[*3] and genuine photo paper to produce photos with a 300-year album storage, 30-year light fastness, and gas fastness of 20 years.[*4]

Multiple performance demands are simultaneously placed on the inks used in Canon inkjet printers, including heat stability, the maintenance of fine droplet configuration (proper spheres of 1 pl), and safety. Bright coloration, high ink density, and fade resistance are also vital. Due to the modification of the dye architecture of the ink and the addition of a new longevity improver to the photo paper, gas fastness has improved significantly. In addition, the ability to reproduce colors in the red region has been expanded, making it possible to preserve fresh, rich colors over an extended period of time.

*3 Dye inks
A type of ink in which the coloring material is dissolved at the molecular level; ideally suited for use in photo prints.

*4 300-year album storage, 30-year light-fastness, and gas-fastness of 20 years.
Permanence figures are projections based on tests conducted under accelerated environmental conditions and are not guaranteed. More detailed information about how these projections are calculated, and the criteria used, can be found on the website below.
http://www.canon.com/technology/canon_tech/explanation/chromalife.html

Auto Photo Fix II

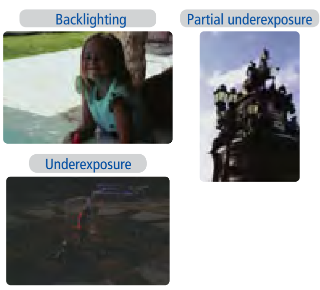
Providing Higher Quality Photo Correction by Multi-Zone Exposure Correction

Canon Auto Photo Fix technology is a technology that automatically analyzes and classifies photographs and makes appropriate corrections.

Auto Photo Fix identifies faces in the image, then analyzes the features of the image and infers the type of scene. Corrections are then implemented based on the face identification and scene classification results. Auto Photo Fix uses face identification technology that is significantly more advanced than conventional face identification technologies. Scene categorization makes use of image analysis technology based on detailed analyses of a huge database of photo images.

For portraits, Auto Photo Fix detects subjects' faces and optimally adjusts skin tones and brightness. With scenery photos, emphasis is placed on making the photos as colorful and striking as possible. When a photograph contains both faces and scenery, the technology aims for an automatically well-balanced image by producing natural skin tones against a vivid background. Furthermore, by identifying underexposed areas in the photo, brightness can be optimized as needed by area.

Input images (examples)



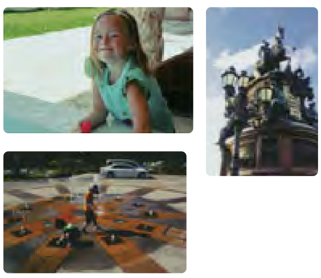
Scene optimization

① Identifies face areas in the image.

② Analyzes the image and infers the type of scene.

③ Optimizes the correction effect using the results of categorizing scenes.[*5]

Optimized results (examples)



Auto Photo Fix II Process

*5 Optimizing correction effects
Specific forms of correction include brightness correction by area, color cast correction, exposure correction, face color correction, and face brightening (backlight adjustment). On the basis of the scene categorization results, Auto Photo Fix implements scene-type optimization (tone adjustment and increased saturation); depending on the scene, specific colors may be emphasized to achieve optimal correction.

Large-Format Inkjet Printers

The technology found in Canon inkjet printers is changing the large-format printing world. FINE print head technology (→ P.36) has led to the development of wide print heads that provide high-definition, high-speed printing on large-scale media. Large-format inkjet printing offers a wide range of applications, including artwork to adorn walls, architectural CAD, and cultural projects.

Overview of Large-Format Inkjet Printers

Using the same principle as a conventional inkjet printer, a heater causes bubbles to form in the ink, ejecting microscopic ink droplets to print on large-format media.

High-Capacity HDD
Temporarily stores print data from a computer. In addition to reducing the time required from issuing print instructions to the completion of output, it enables the printing of the necessary number of copies without using a computer

Multiple Sensors
Adjust the head position, detect paper width, and automatically calibrate colors

L-COA
An image processor that processes large volumes of image data and creates print data (Located on the printed circuit board)

High-Capacity Ink Tanks
Between 5 and 12 individual color ink tanks supply ink to the print head via tubes
► LUCIA/LUCIA EX
► Reactive Ink Technology

Sub Ink Tanks
Buffer ink tanks located inside the printer itself for storing a certain amount of ink. This enables the replacement of ink tanks without needing to stop printing

Carriage
Transports the print heads horizontally. Incorporates a sensor to read print results and a cutter in addition to the print heads

Print Head
This one-inch-wide (2.54 cm) head can print six colors. There are 1,280 nozzles per inch (one row) and two rows for each color

L-COA

High-Speed Performance, from Image Processing to Printer Control

The L-COA image processor, the heart of Canon's large-format inkjet printers, processes large-volume image data and compiles printing data*1 to provide optimal control of the printer. L-COA controls the one-inch-wide print heads, which eject ink droplets as small as 4 pl*2 from up to 30,720 nozzles, to enable high-speed,*3 high-resolution large-format printing.

L-COA was developed using Canon's System LSI Integrated Design Environment technology (→ P.63). L-COA integrates onto a single chip functions that had previously been handled by multiple chips, including protocol processing, image processing, and printer control. System processing is also integrated for faster processing, a shorter communication time lag, and greater speed.

L-COA Image Processor

*1 Large-volume image data
The data volume required for printing an A0 sheet (841 x 1,189 mm, sixteen times the size of a sheet of A4 paper) is approximately 3 GB.

*2 pl (picoliter) : 1 pl = one trillionth of a liter

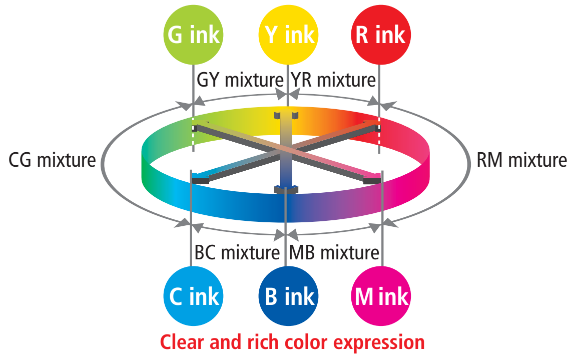
*3 High-speed printing
An A0-size print can be created in approximately 53 seconds.

LUCIA/LUCIA EX

High-Quality 12-Color Pigment Inks to Satisfy Demanding Professionals

Canon has developed the LUCIA 12-color full pigment ink system for large-format inkjet printers, and the quality of its output has been highly regarded.

The new LUCIA EX pigment ink system increased the color reproduction range by up to 20% by using more vivid pigments for all 12 colors and through the use of pigments with a variety of particle diameters. Furthermore, we have successfully produced a dark black using an ink design for raising the grade of black in order to meet the demand for high image quality from professional photographers and creators. By also improving ink materials, we successfully reduced bronzing[*4] and improved rubfastness.[*5]



Comprehensive Color Expression with CMYRGB Inks

*4 Bronzing
A phenomenon in which colors seem to differ from the original color or have a metallic shine due to diffused reflection of illumination on the print surface.

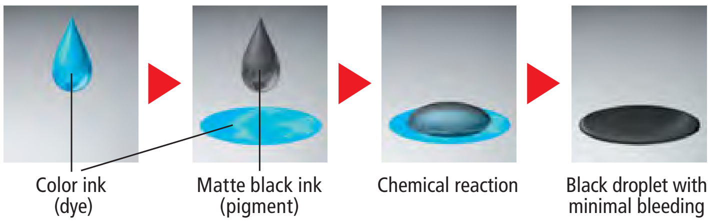
*5 Rubfastness
Ink's rubfastness refers to preventing the surface from peeling or being scratched when a printed surface is rubbed.

Reactive Ink Technology

5-Color Dye and Pigment Inks for High-Definition CAD Printing

Printing architectural drawings and design plans requires accurate printing of fine lines. Canon-developed reactive ink technology exploits the reaction between CMYK dye inks and pigment-based matte black ink to prevent blurring along the edges of text characters and lines.

Five-color dye and pigment reactive inks create clear, crisp black output, making possible the printing of ultra-small text with a placement accuracy of ±0.1% and a minimum line width of 0.02 mm. A rendering resolution of 1,200 dpi enables the smooth reproduction of oblique lines and curves, ensuring the clear presentation of small text characters.



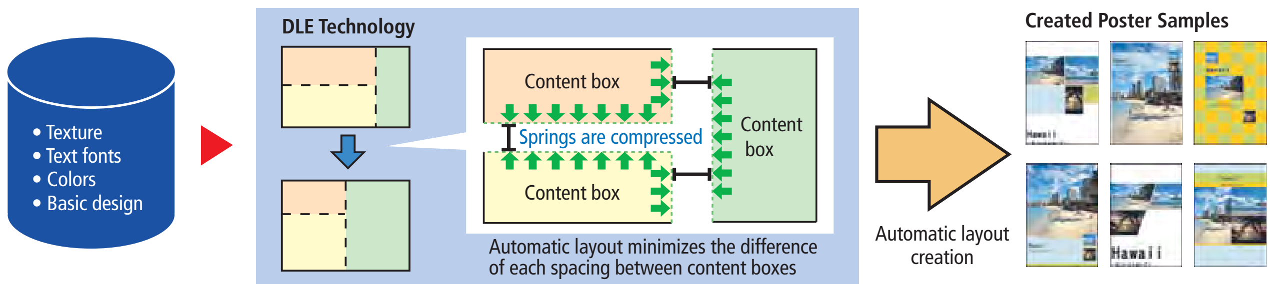
Reactive Ink Technology

Dynamic Layout Engine (DLE)

Easy Automated Creation of Poster and Album Layouts

PosterArtist, Canon's poster-creation software for large-format inkjet printers, incorporates Canon's proprietary DLE technology. DLE automatically provides layouts optimized for the number and size of the elements to be included, creating professional-looking results without the need for complicated operations.

The basic algorithm used in the DLE serves as a spring-like adjustment function and flexibly changes the spacing between each variable-sized element containing photographs or text. It automatically enables to optimize the size of each element while minimizing the difference of each spacing between those elements. With the newly developed auto design function that uses this algorithm, users simply input a minimum amount of information required for design, such as the targeted image, text and image data, and the software automatically creates design drafts in optimal color arrangements and layouts.



Auto Design Function

Laser Printers

Canon has rapidly responded to user needs from a variety of angles in the development of its laser printers. To meet the demands of the times, Canon continues to develop products while striving not only to improve such basic performance aspects as image quality, speed, and ease of use, but also providing network compatibility, extensibility, and eco-friendly performance.

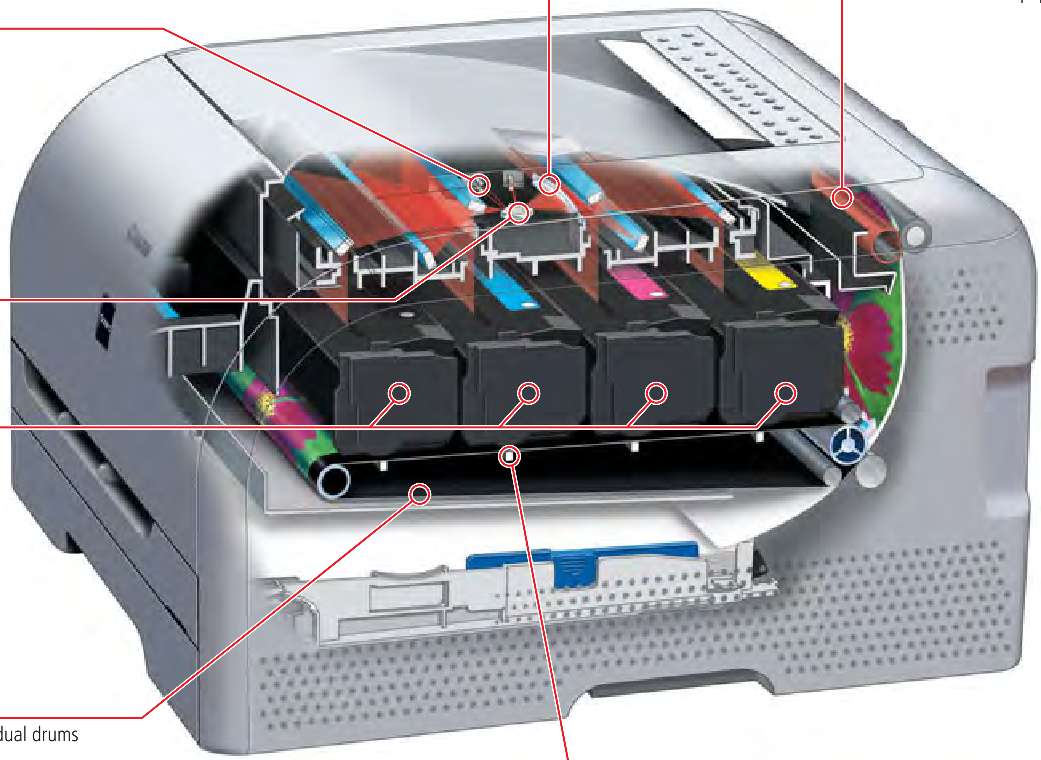
Overview of Laser Printers

Through the electrophotographic printing process (→ P.19), laser beams scan the surface of photosensitive drums to form a latent image.
Toner is then affixed to non-charged areas of the drums to develop the latent image, and finally transferred to paper for printing.

Lens System
Lenses guide the laser beams from the polygon mirror to the individual photosensitive drums

Fixing Belt
Applies heat and pressure to fix the toner to the paper

Laser Diode
This unit emits laser beams in the four CMYK (cyan, magenta, yellow, and black) colors



Polygon Mirror
The mirror spins at a high speed (20,000 to 30,000 rpm) to scan the laser beams

All-in-One Cartridges
For ease of maintenance, each cartridge includes a single integrated photosensitive drum and developing unit for each of the CMYK colors

Intermediate Transfer Belt
Combines the toner images formed on the individual drums and transfers the image to the paper

Transfer Pad
Applies a positive charge to induce transfer from the photosensitive drum to the intermediate transfer belt. This new device replaces conventional transfer rollers
► **Pad Transfer High-Image-Quality Technology**

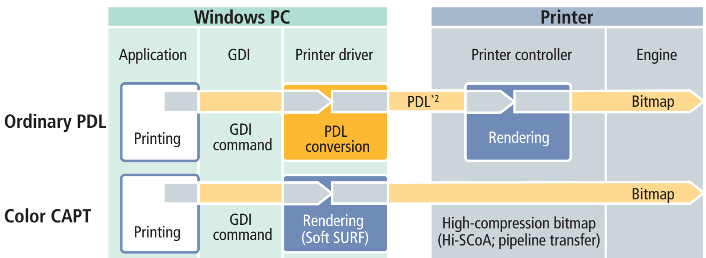
Color CAPT (Canon Advanced Printing Technology)

Reducing Printer Load to Realize High-Speed Output

Image data output by printers is generated by Color CAPT driver software, installed on the host PC, and the printer controller.

An advantage of Canon's Color CAPT technology is its ability to perform at high speeds everything from GDI*1 commands to data rendering and compression on the host PC, then send this data via the interface to the printer controller memory. The function of the printer controller is not to conduct the image processing of data, but to decompress the highly compressed data stored in its memory.

Utilizing high-performance PCs in this way makes possible high-speed printing, even of pages containing large volumes of data, using minimal printer memory and without burdening the printer controller. The latest version of Color CAPT, Color CAPT 3.0, provides improved network connectability to make printing even more convenient.



Conceptual Diagram of Color CAPT Data Processing

*1 GDI (Graphic Device Interface)
A graphics processing program included in Microsoft Windows.

*2 PDL (Page Description Language)
A language used to provide printing data instructions regarding location and format data for text and graphics.

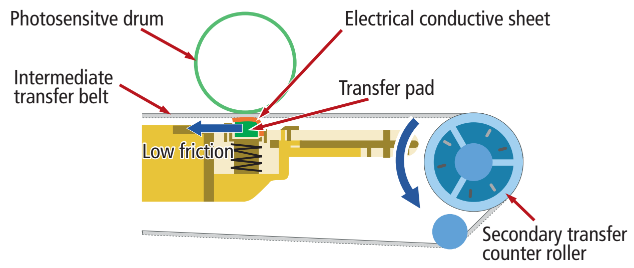
Pad Transfer High-Image-Quality Technology

Electric Field Control Technology for Simple Architecture and Improved Image Quality

Color laser printer images are formed when the yellow, magenta, cyan, and black toner image on a photosensitive drum is initially transferred onto an intermediate transfer belt in succession and the four colors are layered on top of one another. In the past, a positive charge was applied to the transfer roller to cause the negatively charged toner to transfer onto the belt.

In Canon's newly developed Pad Transfer High-Image-Quality Technology, a pad and special electrical conductive sheet with low friction resistance convey toner onto the intermediate transfer belt for the primary transfer. With conventional rollers, it was necessary to add extra components or make the roller bigger to prevent toner from scattering due to such phenomena as delamination discharge.

Canon's Pad Transfer High-Image-Quality Technology uses an electrical conductive sheet to eliminate the need for additional components, achieving a small, simple configuration. Applying a positive charge to the sheet draws the negatively charged toner onto the intermediate transfer belt without scattering toner for the printing of text that is sharp and clear. Less electrical resistance in the sheet makes possible a 90% decrease in voltage needed for transfer, contributing to a smaller overall printer size and lower costs.



Pad Transfer High-Image-Quality Technology

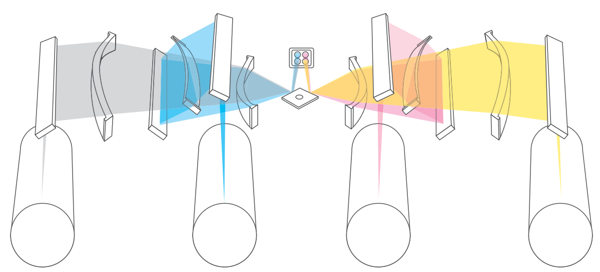
Ultra-Compact Design Technology

Reducing Height to Realize Slim Color Laser Printers

Canon has engaged in a variety of technical overhauls in response to the need for compact-size laser printers, which are often located on or near desktops in office environments. Canon's Ultra-Compact Design Technology, responsible for the realization of ultra-slim A4 color laser printers measuring 262 mm in height, is a composite of different technologies that contribute to smaller, slimmer designs.

● 4-in-1 Ultra-Slim Laser Scanner

In conventional laser scanners, each of the four photosensitive drums requires a laser scanner. Canon's 4-in-1 Laser Scanner is a single scanner unit that projects four color laser beams onto a polygon mirror at oblique angles, splitting the light path into four directions to guide each beam towards its respective photosensitive drum. Positioning the polygon mirror at a low level in the center of the scanner unit and meticulously designing the paths of the beams made possible the 4-in-1 Ultra-Slim Laser Scanner's minimal overall height of 50 mm.



4-in-1 Ultra-Slim Laser Scanner

● Slim High-Voltage Electrical Component Technology

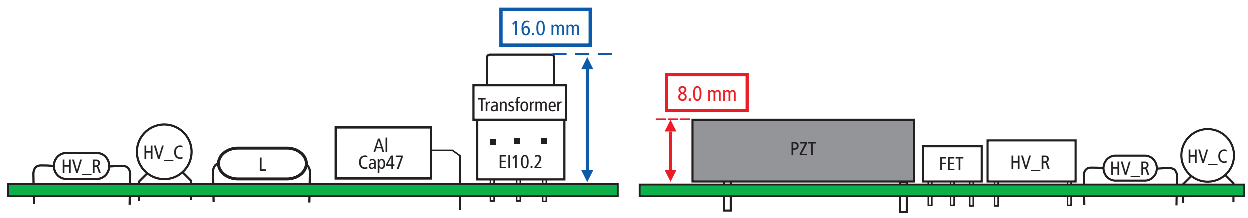
In its pursuit to create a slimmer and more compact laser printer, Canon developed a slender high-voltage power board that is recessed into the side of the printer. Although laser printers require high voltage and tend to have large power boards, a slimmer design was achieved by replacing the traditional electromagnetic transformer[*3] with a piezoelectric[*4] transformer to reduce height by about 50% to 8.0 mm. Canon also adopted a new integrated circuit design, reducing the size of the transformer frequency control circuit by approximately one third.

● Slim Structural Design Technology

Canon also decreased the size of laser printers by arranging toner cartridges horizontally instead of vertically and developing a draw-type operation. The design of the printer body features a new "fanless" design, which exploits natural convection to eliminate the need for a heat-dissipating fan, and a rigid, lightweight construction.

*3 Electromagnetic transformer
A transformer that uses electromagnetic induction to change voltage. Previous electromagnetic transformers used electromagnetic coils for induction.

*4 Piezoelectric transformer
A transformer that exploits the piezoelectric effect of a piezoelectric element (ceramic) to change voltage.



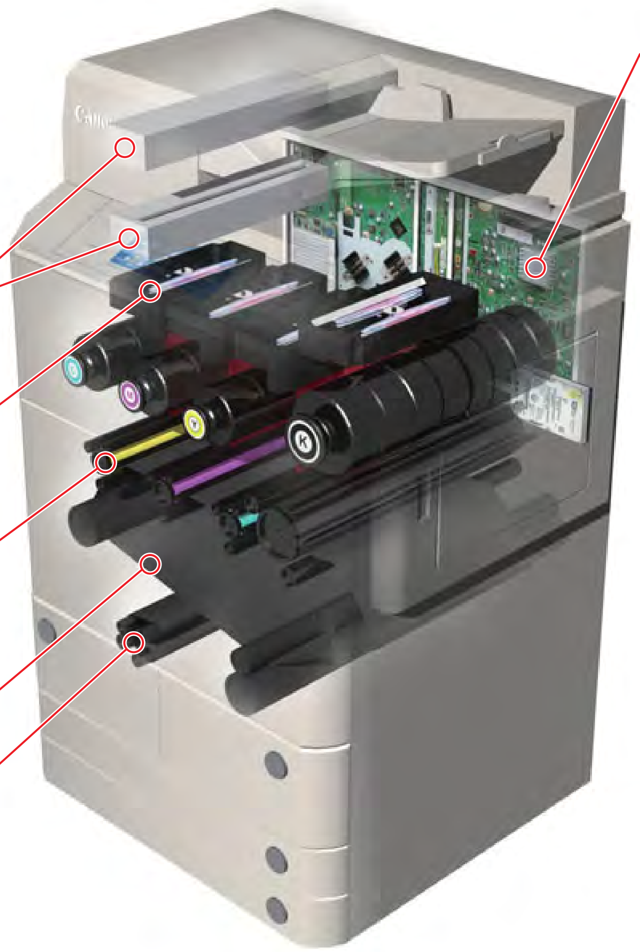
High-Voltage Power Board with Ultra-Slim High-Voltage Electrical Component Technology

Network Digital MFPs

Network digital MFPs allow multiple office imaging tasks, such as input, output, storage, and transmission of documents, to be performed by a single device. Canon has drawn on its expertise in developing electrophotographic technologies to combine advanced network, document processing, and software and device technologies in a single unit. Canon's network digital MFPs also aim to provide enhanced security technology to meet today's business needs.

Overview of Network Digital MFPs

Network Digital MFPs print documents using the electrophotographic printing process (→ P.19). An MFP utilizes either a tandem system, as illustrated on the right, in which each CMYK (cyan, magenta, yellow, black) color has its own laser unit and drum unit; or a single-drum system, in which one drum is used to form images.



iR Controller

The heart of the network digital MFP for controlling image processing and information processing

► Controller Architecture

Scanner Units

A mechanism for scanning documents using an optical system comprising a 4-color line sensor, a white LED and a free-form mirror

► Single Pass Two-Sided Scanning Technology

Laser Units

Uses laser beams to scan the photosensitive drum, exposing the surface of the drum to form an image. Positioned for each CMYK color

Drum Units

A photosensitive drum, electrical charging roller, cleaner, developing unit, and developing roller are incorporated into each compact drum unit, with one drum unit provided for each of the CMYK colors

► Compact Long-Life Drum Cartridge System

Intermediate Transfer Belt

Combines the toner images formed on the photosensitive drums for each color and transfers them to paper

Fixing Unit

Applies heat and pressure to fix transferred toner to paper

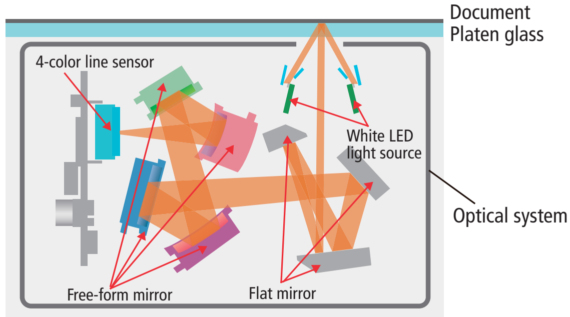
Single Pass Two-Sided Scanning Technology

Contributing to High-Speed Scanning and More Compact Network Digital MFPs

Normally, when reading both sides of a document, it has been necessary to flip the document over using a feeder*1 and read each side separately. Optical systems have had complex configurations with scattered parts in the past, and by arranging these into a single unit, Canon made it possible to place scanner units on the feeder side and the platen glass side. This enables simultaneous scanning of both sides of a document in a single pass, resulting in significantly faster scanning. Furthermore, this reduces the risk of damage to documents while scanning caused by paper jams, etc., and also eliminates the operating noise created when flipping documents.

This scanner unit utilizes a compact high-performance 4-color line sensor, white LEDs and a proprietary free-form mirror unique to Canon.

The specially designed 4-color inline sensor has a faster data transfer rate than conventional sensors, enabling faster scanning. By using a white LED light source, power consumption has been reduced to one quarter of the level when using a xenon lamp. Furthermore, using a free-form mirror provides a greater depth of field than in the past, making it possible to reproduce a sense of depth when scanning an item with an uneven surface. The optical path length is also 47% shorter, and the scanner unit has been successfully made more compact, this also contributes to reducing the space consumed by network digital MFPs.



Scanner Unit

*1 Feeder
A mechanism for automatically transporting the document to the scanning section.

Controller Architecture

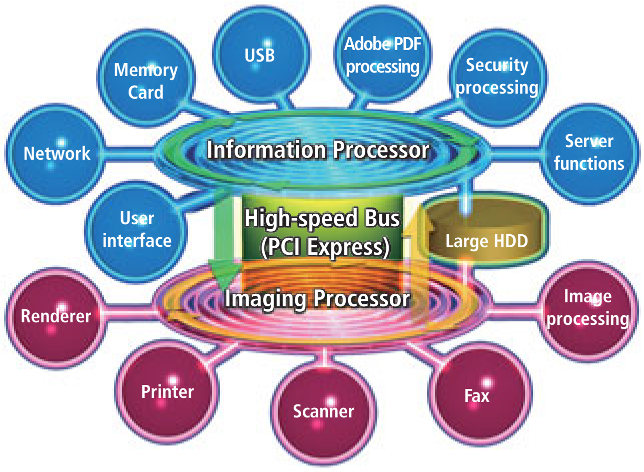
Efficiently Implementing Random Processing on Network Digital MFPs

As network digital MFPs that carry out concurrent processing such as printing and scanning handle enormous volumes of data, the heart of such products needs to efficiently process multiple functions. Canon is developing dedicated processors to suit these products.

To increase overall system performance and the ability to respond to solutions, the newly developed "Advanced iR Controller" is made up of an image processing controller section equipped with an image processor, and an information processing controller section equipped with an information processor. Not only is processing speed maximized by connecting these two controllers using a high-speed PCI Express bus, but it is also possible to adapt to the evolution of document workflows by optimizing each of the controller sections.

The imaging processor incorporates advanced image processing technologies such as VL compression,*2 advanced smoothing and trapping, in addition to providing faster printing and scanning, which are the basic functions of a digital MFP.

The information processor used for processing the user interface, security and connections with external systems boasts excellent compatibility with the network environment and provides many new functions thanks to its excellent information processing capabilities.



Overview of the Advanced iR Controller

*2 VL compression
VL in VL compression is an abbreviation of "visual lossless" and refers to efficiently compressing while limiting image degradation.

pQ (Pure Quality Color) Toner

Contributing to the Improvement of Color Reproduction

A pQ toner has micro-dispersed wax components within the toner particles, which realize oil-less fusing and enable uniform gloss. By utilizing the micro-dispersed pigment components developed for V-toner (→ P.49), the reproducible color space is expanded and the color reproduction of digital MFPs is improved. Furthermore, toner transfer performance was also improved by modifying the surface shape of the toner. This makes it possible to reproduce the toner image more faithfully, enabling the output of clear figures and graphs with sharp text and details.

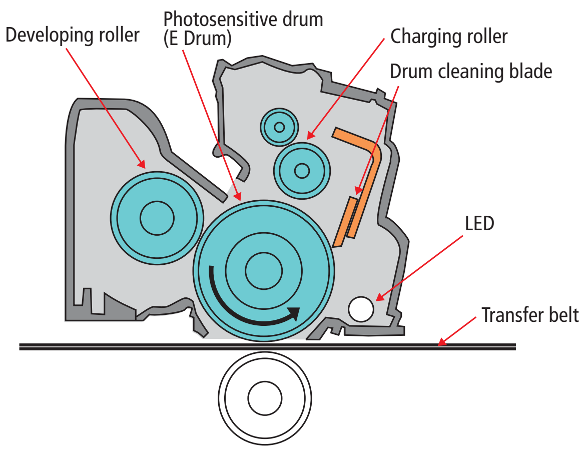
Compact Long-Life Drum Cartridge System

Combining High Image Quality with Reduced Maintenance and Resources

Digital MFPs that print using the electrophotographic printing process have required regular maintenance due to wear of the photosensitive drum. Canon has developed a compact long-life drum cartridge to contribute to the reduction of instances of maintenance and the saving of resources.

The E (Excellent) drum incorporated in this system is a photosensitive drum boasting high durability and high stability due to the addition of a layer of specially-developed coating.

The Compact Long-Life Drum Cartridge System utilizes the long-life properties of the E Drum, while adding 3 new mechanisms to ensure it is more compact at a lower cost. The "electrical charging roller cleaning mechanism" reduces contamination and achieves a significantly longer lifetime by adding a cleaning component to the electrical charging roller. The "cleaner pre-exposure mechanism" contributes to providing a more compact size at lower cost by using an LED as the light source for removing residual charge from the photosensitive drum after exposure. Furthermore, the "toner removal cleaner mechanism" reduces abrasion of the photosensitive drum by not fixing the cleaning blades in place.



Compact Long-Life Drum Cartridge System

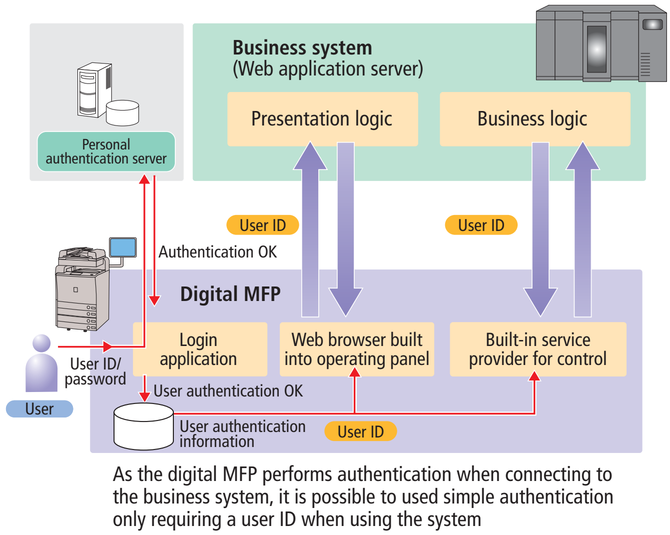
MEAP/MEAP Connector/MEAP Web

Supporting the Building of Business Models

"MEAP"*1 is an application platform incorporated into Canon digital MFPs. Applications customized to suit users' needs can be run without the use of a PC. MEAP, which realizes independence from the operating system using Java technology, is mainly comprised of three elements; the MEAP platform providing the basic runtime environment, the MEAP system service providing system-related functionality, and the MEAP application.

"MEAP Connector" is a technology based on MEAP. Business systems for forms, etc., which digital MFPs could not directly output in the past, can now be closely linked to digital MFPs as part of the workflow.

"MEAP Web" makes it possible to call up digital MFP functions from web applications.*2 Web applications and digital MFPs can be operated seamlessly by using the Web browser displayed on the operating panel. MEAP Web contributes to document-related tasks by dramatically improving the links between digital MFPs and Web-based business systems.



Overview of the Structure of MEAP Web

*1 MEAP : Multifunctional Embedded Application Platform

*2 Web application
Web applications are programs that use web functions. When a user makes a request, the server provides a mechanism that generates and provides content.

Printing System

Improving Output Performance

Producing high-speed, high-resolution output on network digital MFPs creates a heavy load for the printer controller. Canon has developed a printing system that performs optimal data processing for each product and provides efficient high-speed/high-resolution output, without placing excessive strain on the printer controller.

● UFR II/UFR II LT

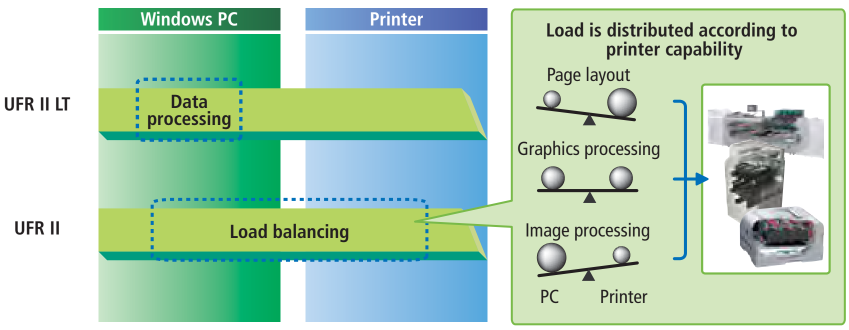
Canon network digital MFPs and laser printers incorporate UFR II, developed by Canon for printers. UFR II uses a load-balancing feature to efficiently distribute the processing burden of all components of printer data between the PC and the printer, and also facilitates optimal data processing in line with the printer's RIP*3 capabilities.

UFR II LT, the page description language used in low-cost machines, also uses UFR II technology to carry out PC data processing, enabling high-speed printing even on printers with low processing capabilities.

● High-Speed RIP

In ordinary printers, RIP is processed by software (software RIP). However, in the case of color printers, which handle large volumes of data, it is often impossible to use software RIP for high-speed data processing, meaning that hardware RIP is necessary.

With the aim of enhancing high speed and high resolution of printers, Canon has developed the core technology for high-speed RIP, which can be used as either software RIP or hardware RIP, and will continue to incorporate this into its products. Additionally, Canon is furthering the optimization and parallelization of internal processing in order to accommodate higher speed, and is developing technologies to enable high-resolution data processing by high-speed internal data compression.



UFR II Load Balancing

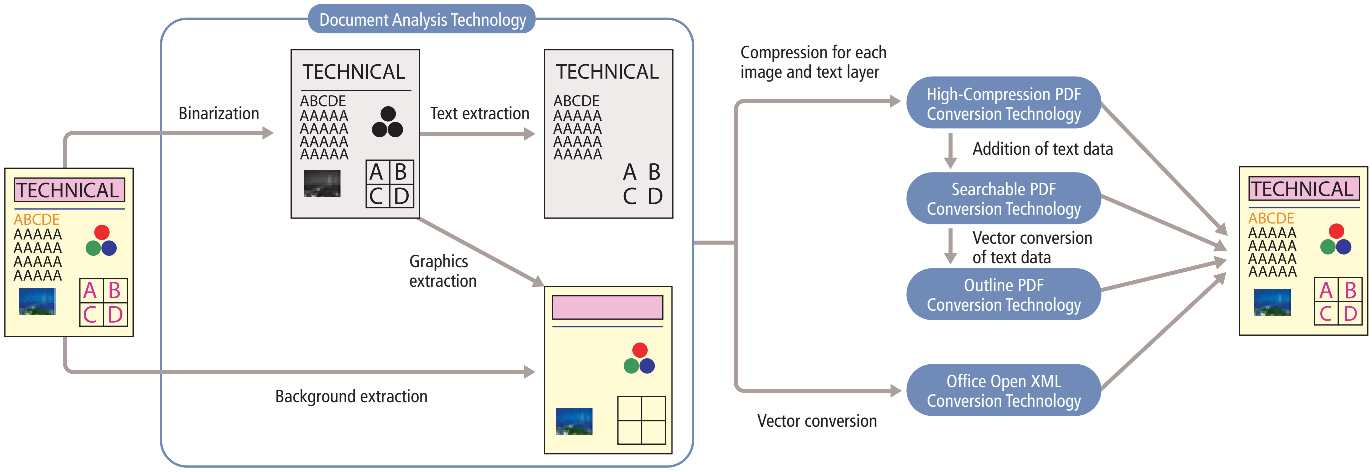
*3 RIP
Raster Image Processing, a process for creating bitmap data from a page description language (PDL).

Document Processing Technology

Automatically Analyzing Scanned Documents to Create Reusable High-Quality Electronic Documents

Canon network digital MFPs do more than just make copies of scanned data. Built-in "document processing technology" enables the creation of reusable electronic documents by analyzing and processing scanned documents.

The first step in document processing technology is document analysis. "Document analysis technology" is used to analyze the layout of a scanned document to extract objects such as texts, diagrams, photographs and graphics, and separate them into their respective areas to generate basic data of each attributes, positions and sizes. These basic data are then processed with character recognition, vector conversion,*4 image processing, and compression by which high-quality documents are created.



Overview of Electronic Document Creation Based on Document Processing Technology

● High-Compression PDF*5 Conversion Technology

High Resolution with Lower Data Volume

"High-compression PDF conversion technology" employs document analysis technology to extract text and image data and separate them into multiple layers. This technology enables each layer to then be optimally compressed, providing for a high-compression ratio while maintaining high resolution.

Using conventional compression methods, an A4-size color image scanned at 150 dpi can be compressed to a file size of about 2 MB. With this technology, the same image scanned at a resolution equivalent to 300 dpi can be reduced to roughly one tenth of that size (200 KB). Canon is the first company in the world to incorporate this technology into MFPs, and has dramatically improved the capability of handling color document image data, which entails particularly high volumes of data.

● Outline PDF Conversion Technology

High-Resolution Text Display in Various Environments

"Outline PDF conversion technology" represents the evolution of high-compression PDF conversion technology. While this technology conventionally composes text and background data extracted from scanned images, Canon's outline PDF converts text data into vector data and then compresses it to make possible the display of high-resolution text regardless of the resolution of the output devices.

Text and graphics data converted with outline PDF can also be reused in Adobe Illustrator, expanding the range of reusability for scanned documents.

● Searchable PDF Conversion Technology

Searching For Text in Image PDFs

"Searchable PDF conversion technology" enables text search within PDF documents by overlaying text, identified and extracted as data using document analysis technology, on the original image as a text layer. The technology achieves a fast processing speed of 7.5 pages per minute for A4-size documents, with a high accuracy rate of 97.75% (based on in-house Japanese-language evaluation samples).

In addition to Japanese, this technology supports English as well as various European and Asian languages.

● Office Open XML Conversion Technology

Promoting the Reuse of Paper Documents

"Office Open XML conversion technology" enables to convert files into the new XML-based file format adopted by Microsoft Office 2007. When scanning paper documents, this technology can change text and diagram data into vector data, and convert the documents into PowerPoint format retaining images, background and the layout. This makes it easier to change texts and diagrams compared with the conventional PDF conversion, substantially reducing the work required for data input and editing even when the original is a paper document.

*4 Vector conversion
This refers to conversion into a graphic expression format (vector data) that saves shape information independent of resolution. This enables smooth contours to be maintained even when an image is enlarged.

*5 PDF (Portable Document Format)
A document conversion format developed by Adobe Systems Inc. widely used for exchanging documents and displaying documents on the Internet.

Smooth Text Reproduction in Various Environments

Document Solutions

Maximum Utilization of Hardware Functions

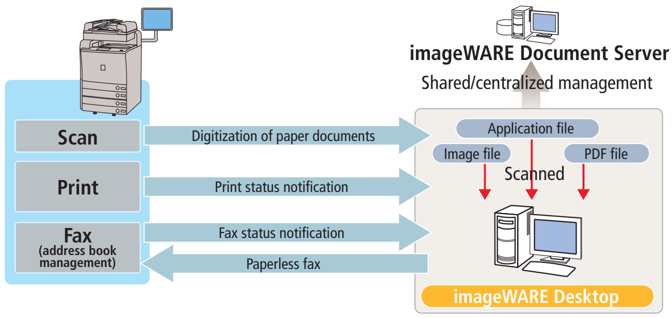
In addition to hardware devices such as network digital MFPs and digital color production systems, Canon has developed the imageWARE series of software products. Canon document solutions digitize paper documents for more effective use, improving office workflow efficiency and reducing costs.

●Business Solutions for Users

○imageWARE Desktop

Consolidating Document Work and Improving Productivity

Canon's imageWARE Desktop is software for supporting tasks related to the input, editing and output of paper and electronic documents in the office. It contributes to improved business productivity and reduced costs by integrating different types of application files. It also improves the efficiency of imageRUNNER ADVANCE use through the monitoring of jobs and use of address books from the PC. Furthermore, the imageWARE Document Server document management system is used to provide sharing and management of office documents.



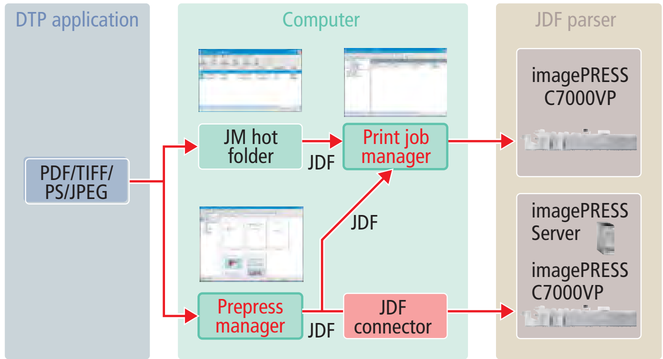
Configuration of imageWARE Desktop

○imageWARE (iW) Prepress Manager / imageWARE (iW) Print Job Manager

Comprehensive High-Efficiency Print Management System

Canon imageWARE Prepress Manager software is designed to support the creation of high-quality prints in the Print On Demand (POD) market. The software combines document data from different applications and scanned image data into a single file, making it possible to edit while previewing an image of the final document.

Canon imageWARE Print Job Manager sets up a centralized system that can manage the operational status and job status of printers installed at remote locations.



System Schematic of imageWARE Prepress Manager and Print Job Manager

●Device Management Solutions

○imageWARE Enterprise Management Console (iW Management Console)

Efficient Printing Device Management for System Administrators

Canon's imageWARE Enterprise Management Console provides the centralized management of tasks that were previously handled by multiple utilities, including printing device setup, address book delivery, and printer driver installation.

○imageWARE (iW) Accounting Manager

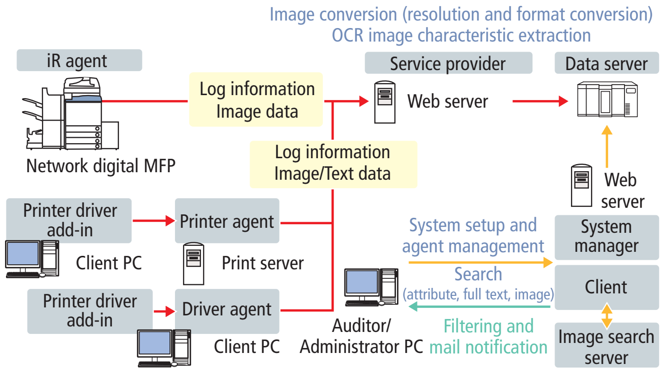
Accurate Recording/Management of Device Use Status

Canon's imageWARE Accounting Manager tallies and analyzes total output records for tasks such as printing and copying by department, user, and device. Each device holds its own records for review as needed.

○imageWARE (iW) Secure Audit Manager

Preventing Information Leaks by Unauthorized Printing or Copying

Canon's imageWARE Secure Audit Manager allows users to store and manage the content of documents used during printing, copying, scanning, and faxing, as image logs in a database. This function proves useful for improving security.



imageWARE Secure Audit Manager System Configuration

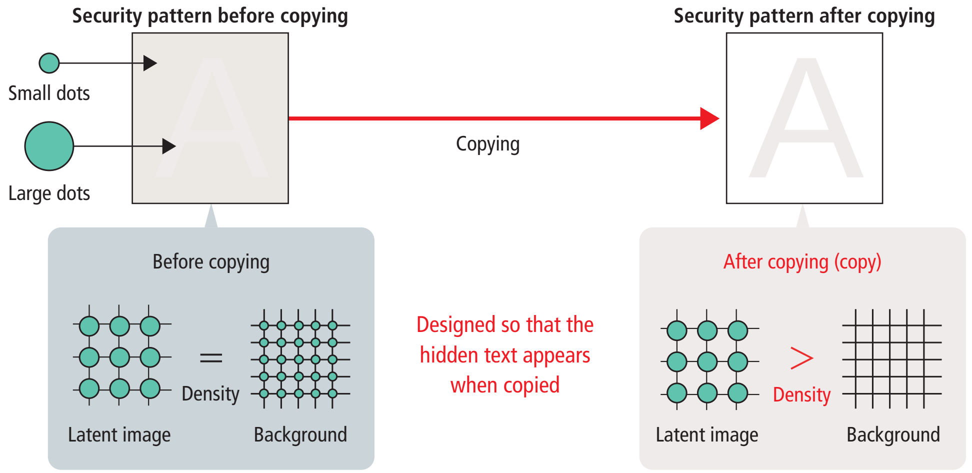
Security Screen Pattern Technology

Protecting Critical Information Without the Use of Dedicated Papers

Canon views the entire flow of office information centered on the network digital MFP as a document cycle, providing total security for paper documents and electronic data through both hardware and software.

Security screen pattern technology is designed to deter unauthorized copying. Canon has developed a security screen pattern-printing technology that can embed hidden text in ordinary paper documents without the use of dedicated papers. If the document is copied, the hidden text appears on copied duplicates.

Security screen patterns are composed of patterns rendered in small dots and a hidden text string rendered in large dots which, when printed, is hidden in the background of the document until copied. Prior to copying, a balance of small and large dots creates the impression of an even background. During the copying process, the small dots are not read by a digital MFP and thus disappear, leaving behind only the hidden text that is printed in large dots. Focusing on processing technology for the boundaries between large and small dots enables a uniform density and prevents hidden text strings from being visible.



Overview of Security Screen Pattern Technology

Digital Color Presses

The imagePRESS digital color press is Canon's first color on-demand printer for professional use. The imagePRESS handles a wide variety of media and achieves outstanding high-definition printout that approaches offset quality, and delivers high productivity and excellent durability and reliability for on-demand, small-volume print jobs.

Overview of Digital Color Presses

Canon's imagePRESS produces printout using the electrophotographic printing method (→ P.19). It delivers the high-precision registration needed for professional color on-demand printing and incorporates a flexible intermediate transfer belt capable of accommodating a variety of print media and dual fixing to achieve uniform print speed for all output.

Laser Unit

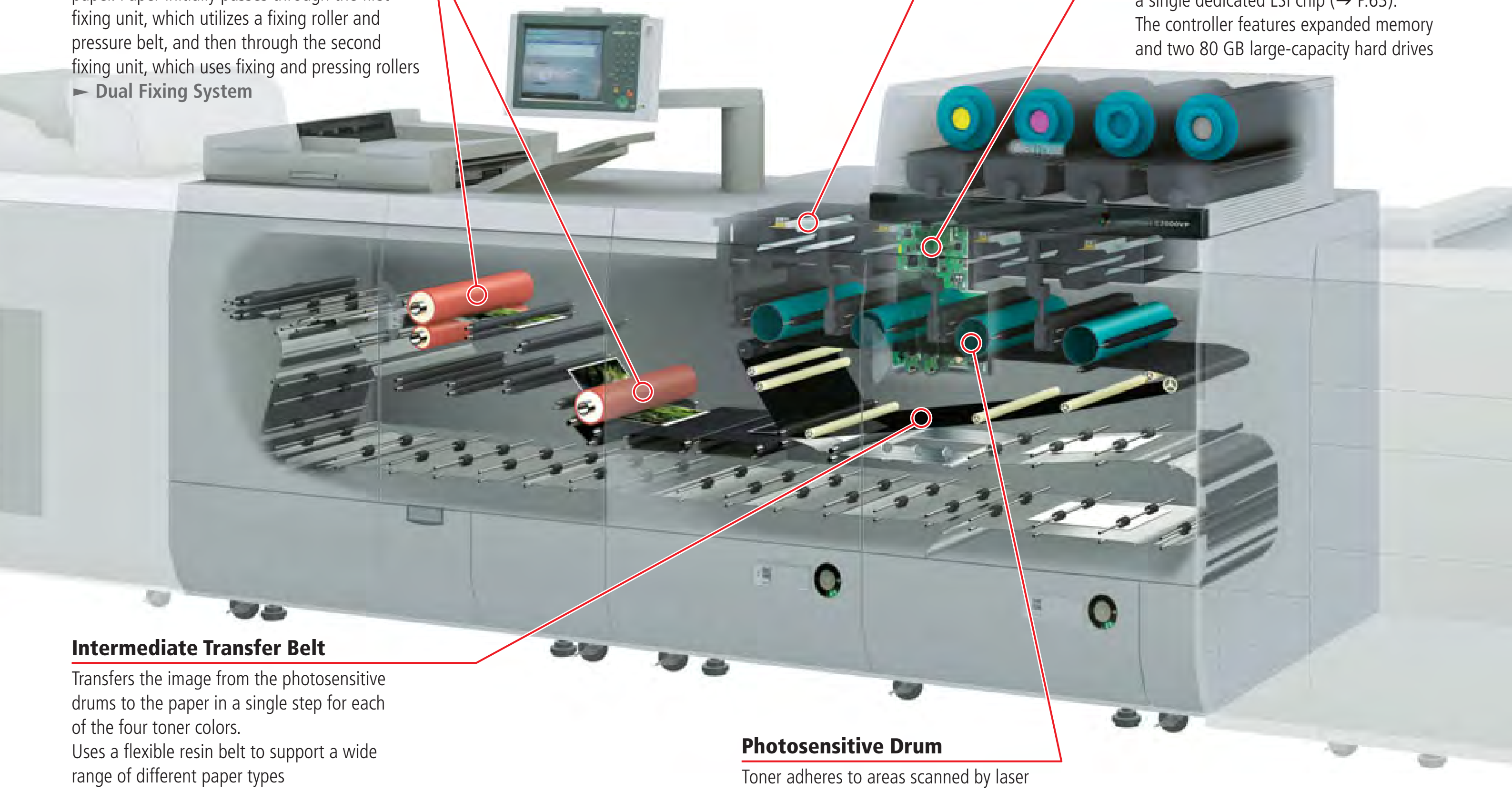
Employs a low-spread red twin-beam laser to write images at 1,200 dpi × 1,200 dpi in 256 gradations, achieving high-definition printout

iPR Controller

The iPR Controller, the heart of Canon's imagePRESS digital color press, integrates a dual-core CPU and graphics engine into a single dedicated LSI chip (→ P.63).
The controller features expanded memory and two 80 GB large-capacity hard drives

First Fixing Unit/Second Fixing Unit

Performs dual-path fixing of the toner onto the paper. Paper initially passes through the first fixing unit, which utilizes a fixing roller and pressure belt, and then through the second fixing unit, which uses fixing and pressing rollers
► Dual Fixing System



Intermediate Transfer Belt

Transfers the image from the photosensitive drums to the paper in a single step for each of the four toner colors.
Uses a flexible resin belt to support a wide range of different paper types
► Auto-Registration

Photosensitive Drum

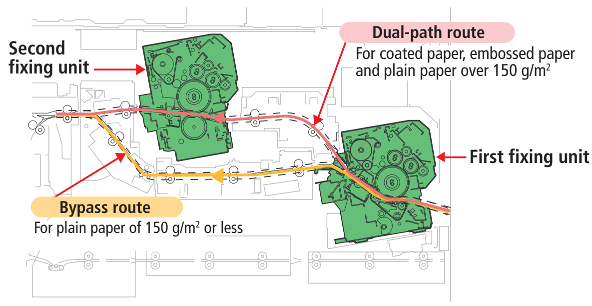
Toner adheres to areas scanned by laser beams to form images on paper

Dual Fixing System

Dual Path Achieves Uniform Print Speed for All Media

Canon's imagePRESS handles thick and coated paper through a two-path system employing two fixing units. The paper initially passes through the first fixing unit, which utilizes a fixing roller and a pressure belt, and then through the second fixing unit, which uses fixing and pressure rollers, to realize high-luster printout. Paper that does not require dual fixing, such as thin or recycled paper, passes through the first fixing unit only.

By automatically adjusting the paper path according to the type of paper,*1 the imagePRESS produces uniform surface luster and maintains a consistent print speed of 70 sheets per minute (A4, landscape) for media types of varying thicknesses.



Dual Fixing System

*1 Type of paper
A wide variety of paper is used in commercial printing, including coated paper and art paper in addition to general-use premium-grade paper, medium-quality paper, and recycled paper. The varying thicknesses of these, along with multiple processing techniques, make for a diverse range of paper types.

Auto-Registration

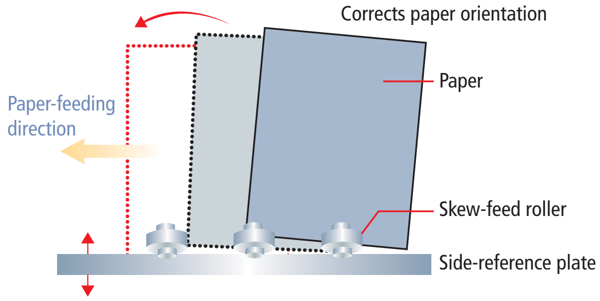
Accurate Image Positioning During Duplex Printing

To ensure proper post-press processes, such as paper cutting and book binding, the imagePRESS must realize high-precision image positioning on the paper. Canon uses three Auto-Registration functions for increased image-positioning accuracy.

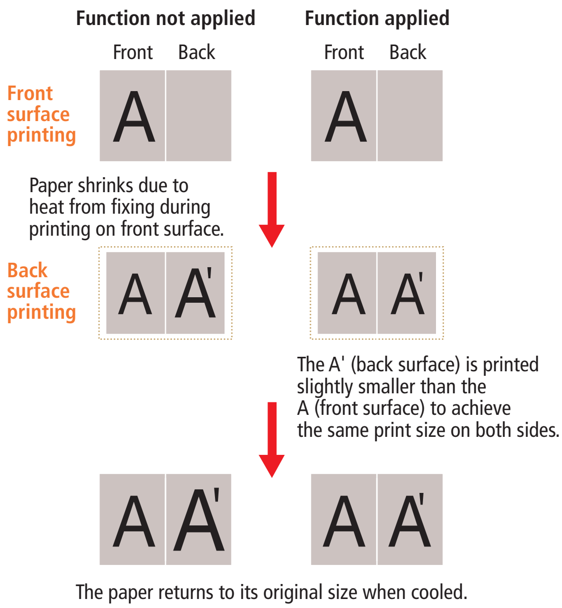
First, Active Registration uses skew-feed rollers to push fed paper against the side reference plate to ensure proper alignment with the image printing direction.

Next, on the intermediate transfer belt, the Registration Patch sensor detects a patch printed at the leading edge of the transfer image. By controlling the transport timing of the paper, this function ensures accurate print positioning between the leading and trailing edges of the paper.

During duplex printing, the paper shrinks slightly due to the heat that is applied to fix the image to the front surface. To prevent paper shrinkage from affecting the printing position, Canon uses 2nd Image Size Reduction to create a slightly smaller image on the back surface so that the printed image size is identical on both the front and back surfaces of the paper.



Active Registration



Overview of 2nd Image Size Reduction

V-Toner

Excellent Color Reproduction that Approaches Offset Quality

Canon's V (Vivid-color) Toner is specially designed for use with the imagePRESS digital color press. V-toner has micro-dispersed wax and pigment components within the toner particles, and improves the heat melting performance in the fusing process. This enables V-Toner to provide optimized gloss that harmonizes with a variety of media to achieve uniform gloss output.

Following yellow, magenta, cyan and black, the recently developed "V-Toner Clear" is a transparent toner that controls the level of gloss on the surface of paper. By utilizing this V-Toner Clear, imagePRESS C1+ is able to produce prints that replicate 3D-like textures and matte effects. The use of the transparent toner also enables the printing of watermarks that can be used for identification when unauthorized copies are made, contributing to the improvement of security for information contained in printed material.

Cyan

Clear

V-Toner (enlarged image)

A 5-Color Cartridge Containing V-Toner

Semiconductor Lithography Equipment

Semiconductors are constantly evolving, achieving ever-higher levels of performance and functionality. Amid this evolution, circuit line widths continue to shrink, decreasing from 45 nm to 32 nm. Canon, through its semiconductor lithography equipment, meets the strict cutting-edge demands of the industry while focusing on the development of future technologies. These technologies serve as the driving force behind Canon's optical and control technologies.

Overview of Semiconductor Lithography Equipment

Semiconductor lithography equipment prints circuit patterns onto silicon wafers using reduced projection exposure. These tools play a vital role in the manufacture of semiconductor chips, a procedure that requires several hundred processes. Because these tools "step" from one chip to the next to expose the several hundred chip patterns on a single wafer, they are also called "steppers".

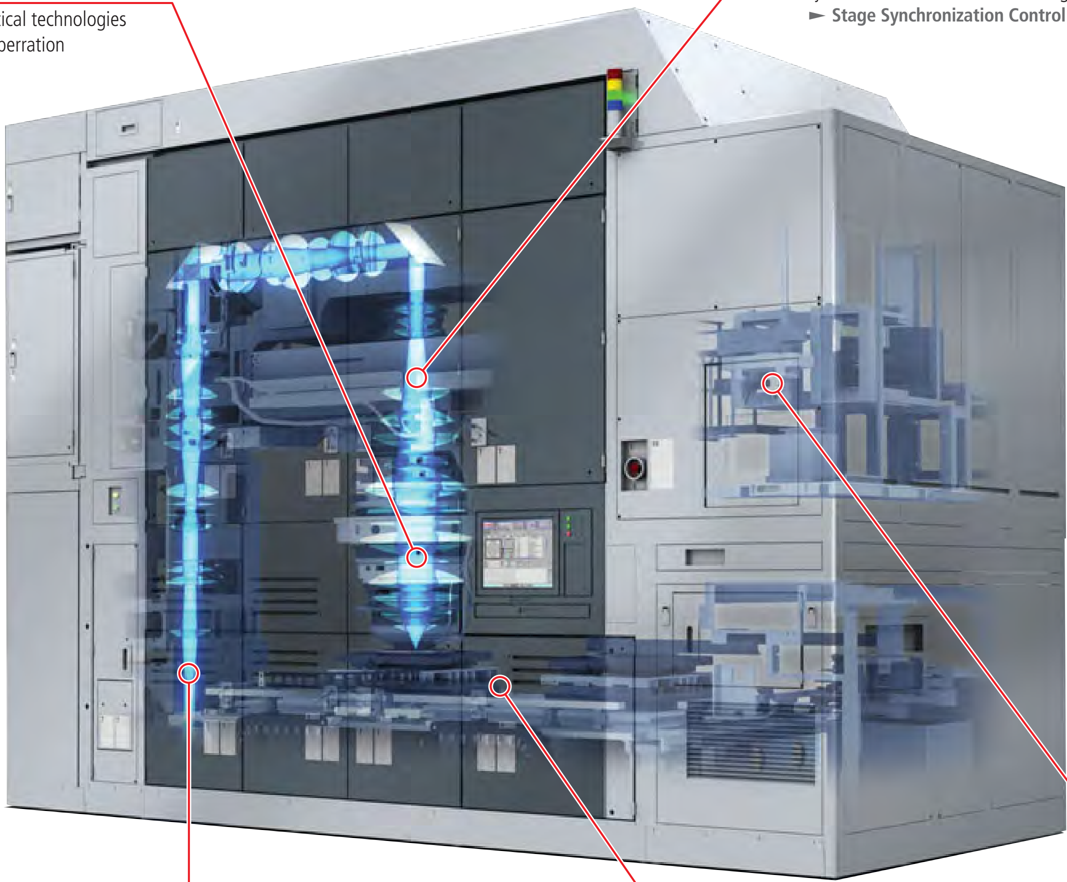
Reticle/Reticle Stage

The reticle, also called a photomask, is a glass (quartz) substrate on which the circuit pattern to be exposed is drawn. The reticle stage secures the reticle and moves in synchronization with the wafer stage

► **Stage Synchronization Control Technology**

Projection Optics

Combines cutting-edge optical technologies to achieve extremely low aberration



Light Source

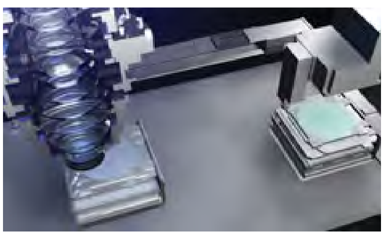
The light source illuminates the circuit pattern on the reticle, using ultraviolet-range light with wavelengths shorter than visible light (i-line lamp, KrF/ArF excimer lasers)

Light	Wavelength
i-line	365 nm
KrF excimer laser	248 nm
ArF excimer laser	193 nm

Wafer Stage

Holds the wafer in place and moves sequentially in synchronization with the reticle stage

► **Stage Synchronization Control Technology**



Reticle Changer

In semiconductor production, the process of exposure, developing, and processing is repeated dozens of times. Accordingly, the reticle changer enables the storage of multiple reticles

Stage Synchronization Control Technology

Achieving High Yield Rates and High Productivity of Semiconductors

Among the technologies supporting the manufacture of semiconductors, synchronization control technology is as important as circuit miniaturization technology. The precision of stage positioning has a direct effect on yield rates, while stage speed affects productivity as measured by hourly "throughput."

Semiconductor lithography equipment which uses the scan and repeat method[*1] carries out wafer exposure while continually synchronizing the movements of the wafer and reticle stages. Ensuring the accurate positioning of reticle patterns on the wafer during exposure with proper focus and uniform light intensity requires the extremely precise control of all moving sections.

To achieve ultra-fine line widths of 45 nm, the flatness of the wafer[*2] also must not be overlooked. If the positioning of both stages and the lens is not corrected for each shot in accordance with even the slightest inconsistencies on the surface of the wafer, the exposure of microscopic circuit lines would not be possible. Commencing with the FPA-7000 series, Canon has mounted two wafer stages, achieving both high precision and high throughput by enabling the parallel operation of wafer-surface measurement and exposure for each stage.

Both stages and the lens are supported against vibration and driven without contact by linear motors. Both stages are 6-axis fine-drive stages and the lens contains multiple self-adjusting mechanisms. As such, the total number of axes subject to synchronization control within the system exceeds 100. Changes in position for each axis are measured by Canon's high precision sensing technology and controlled by dedicated control algorithms.

Both stages use a drive reactive force cancellation mechanism with counter masses that move in the opposite direction for vibration-free acceleration to achieve precise position control.

*1 Scan and repeat method
A method of exposure in which both the reticle and wafer stages move. Compared with the step and repeat method, in which only the wafer stage moves, this approach offers the merits of greater depth of focus while facilitating larger chip sizes.

*2 Wafer flatness
Not only the curvature of the wafer surface as a whole, but even slight imperfections of only a few nanometers within a single shot area (about 20 mm^2) can create problems.

Reverse-Side Alignment

Core Technology for LSI Integration Expected to be Expanded to Postprocessing

In the semiconductor lithography process where a pattern on a mask is projected onto a single wafer numerous times, the position is determined by reading several alignment (positioning) marks on the surface of the wafer. Meanwhile, 3D packaging is believed to be promising for further increasing density, and development of technology for performing alignment using the back of the wafer was hurried in order to achieve this. 3D packaging refers to a technology in which several LSIs containing circuits are placed in layers and a circuit is completed using vertical electrodes to form a single LSI. The process used for forming the holes for the electrodes requires accurate alignment.

Canon has developed the TSA[*3]-scope for reading alignment marks on the back of the wafer by transmitting infrared light through the wafer. This TSA-scope has the benefit of not having a restricted range of measurement when compared to methods that directly detect alignment from the back of the wafer. Moreover, as it can be used in a variety of packaging processes, Canon is developing a diverse range of applications utilizing this as a key technology for products used in postprocessing in semiconductor fabrication.

*3 TSA (Through Silicon Alignment)
An alignment method using long-wave infrared light for observing alignment marks formed on the back of the wafer through the silicon.

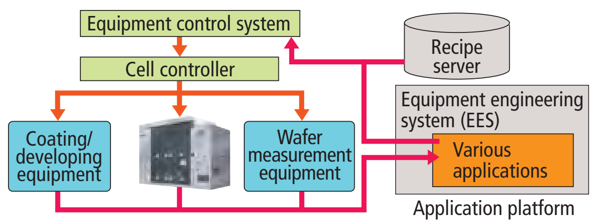
Lithography Equipment Application Platform

Supporting Total Productivity Improvement

Semiconductor lithography equipment software not only achieves maximum performance from the hardware, but also plays a vital role by contributing to increasing total productivity. The application platform that forms the core of the software system is composed of an infrastructure connecting multiple CPUs/OSs and a plug-in framework that supports basic control and data management, making it possible to rapidly adapt to the needs of diversifying semiconductor manufacturers.

Not only does this technology provide a common platform for semiconductor manufacturers' various online, GUI, EES,[*4] and other interfaces, but by opening these to external access, it allows access and precise control of all kinds of internal and external data and makes providing solutions simple.

At present, this platform is being applied to the FPA-7000 series and future plans include linking it with a "recipe server"[*5] to develop it into a solutions system.



Role of Applications

*4 EES (Equipment Engineering System)
Linking not only with lithography equipment but also with peripheral equipment is indispensable for improving precision and productivity in semiconductor manufacturing. EES provides a system and interface for data sharing.

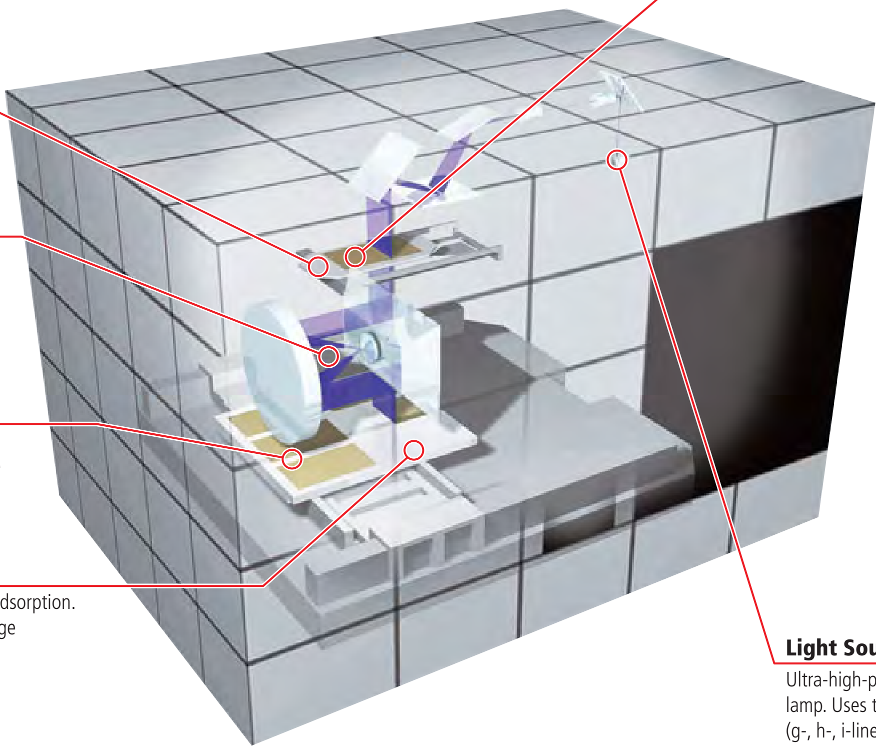
*5 Recipe server
Makes possible the creation and editing of "recipes" (control information) for wafer exposure for each piece of equipment and can be linked to a production management system.

Mirror Projection Aligners

Large-screen LCD televisions are enjoying widespread popularity. LCD panels, a key component of LCD televisions, are created with technology that precisely exposes minute pixel circuits over a wide area on large-scale glass substrates. Canon mirror projection aligners can accommodate 8th-generation glass substrate sizes, making possible the single-exposure production of widescreen TVs up to 57 inches in size. Canon is the leading manufacturer of this equipment.

Overview of Mirror Projection Aligners

Mirror projection aligners transfer fine pixel patterns onto a glass substrate to create liquid crystal display panels for displays and televisions. Canon mirror projection aligners (mask aligners) employ the company's original mirror-scanning method for optical mirror projection.



Mask
Original plate for projection exposure of pixel circuit patterns onto glass substrates

Mask Stage
The stage that secures the mask and moves sequentially in synchronization with the substrate stage

Mirror Projection Optical System
Composed of a trapezoidal mirror, a concave mirror, and a convex mirror. The optical system ensures seamless wide-field exposure
► Large Concave Mirror

Glass Substrate
The glass substrate measures six or eight panels in size. The size differs according to the generation of the substrate. 8th-generation glass substrates measure 2,200 x 2,500 mm (with a thickness of 0.7 mm)

Substrate Stage
Glass substrates are secured to the stage by vacuum adsorption. The stage moves in synchronization with the mask stage
► Ultra-Large Stage

Light Source
Ultra-high-pressure mercury lamp. Uses three wavelengths (g-, h-, i-line) in the UV range

Large Concave Mirror

Manufacturing High-Precision Mirrors with the World's Largest Diameter*1

Canon mirror projection aligners employ a mirror-scanning method that makes use of a mirror-based projection optical system. The system offers such merits as a simple configuration facilitating increases in substrate size, a wide exposure field, no chromatic aberration, which can occur with lenses, and no image performance degradation.

Pattern exposure processes for LCD panels are carried out with a precision of several μm.*2 The projection mirror used in the system also requires high precision. Large concave mirrors in particular, with a large diameter to realize an exposure width capable of exposing large panels seamlessly in a single pass, enable significant increases in productivity.

By making use of extremely high-precision processing technologies (→ P69), Canon has succeeded in developing the world's largest diameter concave mirror, a 1,514 mm 8th-generation*3 ultra-high precision concave mirror with a surface processing accuracy of 0.015 μm. The mirror makes possible a resolving power of 3 μm across the entire exposure field.

Large-Diameter High-Precision Concave Mirror (1,514 mm diameter)

*1 World's largest diameter
Among semiconductor lithography equipment and mirror projection aligners as of August 2010.

*2 Micrometer (μm) : 1 μm = one millionth of a meter.

*3 8th-generation
Ongoing changes in the size of glass substrates are represented as "generations." The larger the substrate, the better suited it is for producing large panels. Productivity also increases as a single substrate yields multiple panels, so the number of generations has risen rapidly. At present, the 8th-generation is being mass produced, but development is already being conducted with an eye to the next generation.

Ultra-Large Stage

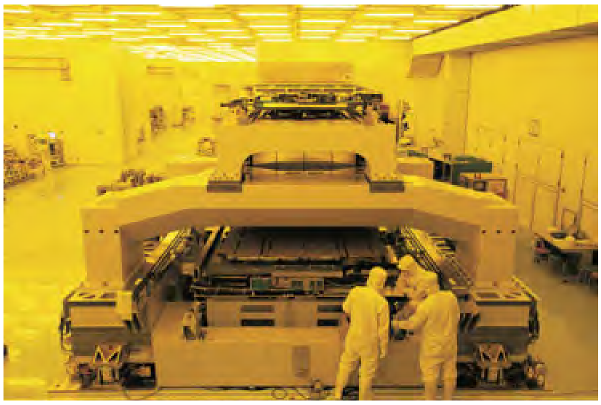
Exposing Large Scale Substrates at a Speed of 750 mm per Second

Canon's latest mirror projection aligner measures 9 m (W) x 11.6 m (D) x 5.8 m (H). The main body of the unit weighs 100 tons, with the moving mask stage weighing 1 ton and the substrate stage weighing 4 tons, making the aligner Canon's largest product.

As the size of LCD substrates increases, the weight of the moveable parts has also increased. Because increased weight tends to impair the performance of the stages, Canon selects materials with a low specific gravity and strong rigidity in order to develop ultra-large stages that reduce overall weight while maintaining component strength.

The substrate stage and mask stage are each maintained by air bearings and are driven by non-contact linear motors.The comparatively light mask stage follows the comparatively heavy substrate stage for completely synchronized "master slave control." The drive performance of the substrate stage realizes an extremely high level of precision, achieving a speed of 750 mm per second in just 0.5 seconds upon moving, and comes to a complete stop in a mere 0.2 seconds upon arriving at the stop position. Both stages utilize positional measuring technology using a laser interferometer to control position and speed. (→ P.67)

The high-performance and high-speed operation of the ultra-large stage allows it to attain a high throughput of 323 panels per hour for 55-inch wide panels.



Mirror Projection Aligner for 8th-generation Glass Substrate Sizes

Group Company Technology —— Canon ANELVA Corporation

Vacuum Deposition Technology

Supporting the Film Deposition Process for Large Panels

Vacuum deposition[*4] technology, used in the wiring process during LCD panel production, forms a thin film in a vacuum using the "sputter deposition"[*5] method. This is a film deposition method that uses the "sputtering phenomenon" to form a thin film of metal, such as the aluminum and molybdenum used in transistor circuit wiring, on glass substrates.

Since its founding, Canon ANELVA has developed original ultra-high vacuum technologies and produced film deposition equipment for semiconductors, storage devices, and panel devices. Canon ANELVA developed the ANELVA System, a vertical transfer system for substrates during the manufacture of LCD panels, which accommodates upgrades in glass substrate generations while solving such problems as substrate bowing, which would occur in conventional horizontally-oriented transfer systems, and equipment installation space. Further, Canon ANELVA also developed the "rectangular split cathode," a unique cathode configuration for sputtering that can expose two substrates at once by consecutive deposition of three types of film material (targets) in the same vacuum chamber. The deposited film delivers uniformly superior quality and also improves the usage rate of the target.

The equipment reduces panel costs while increasing productivity within the rapidly growing LCD panel-production sector.

Sputtering Equipment for LCDs (C-3722 SERIES)

*4 Vacuum deposition
Thin films (thickness of 1 μm or less) are commonly formed on a physical surface by either electroplating or vacuum deposition. Vacuum deposition, which takes place in a vacuum, facilitates the controlling of the film's thickness during formation. Methods of vacuum deposition include "vacuum evaporation," in which the film material is heated and evaporated; "CVD," which makes use of a chemical reaction with a gaseous film material; and "sputter," which uses physical reactions.

*5 Sputter deposition
When voltage is applied to a glass substrate and film material (target) within a vacuum containing argon or other inert gas, the gas becomes ionized (Ar+) and collides with the target at high speed, causing the atoms and molecules composing the target to be ejected (the sputtering phenomenon). The sputtered atoms and molecules adhere to the surface of the substrate in a thin layer.

Broadcasting Equipment & Network Cameras

In addition to being involved in the supply of current HDTV (High-Definition Television) broadcast lenses and network cameras etc., Canon has newly developed a next-generation Super Hi-Vision (SHV) television broadcast lens. Canon's optical technologies effectively meet the demands of professional users for high performance and rugged reliability wherever they are needed.

SHV Zoom Lens

A Super High Performance Lens with Four Times the Performance Capacity of a Full High-Definition Television Lens

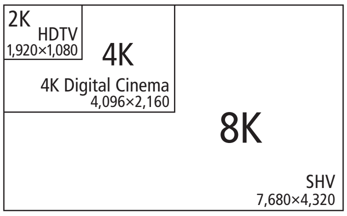
Canon's broadcast lenses have a 50-year history and enjoy solid support thanks to their outstanding optical performance and exceptional reliability. In particular, Canon's zoom lenses are highly praised for the dynamic images that they produce, and are being used in the development of the SHV image capture system that Japan Broadcasting Corporation (NHK) plans to roll out in 2025.

SHV is an ultra high-definition image format of 4,320 vertical scanning lines that contain 16 times the data volume of the full high-definition TV format. The lenses used are required to be capable of a resolution of at least 240 black and white line pairs within a width of 1mm. At such a high spatial frequency, the wave characteristics of light mean that, the narrower the aperture of the lens, the greater the effects of diffraction, whereby lens performance deteriorates. This means that lenses need to be able to correct to the utmost degree any aberration between a bright f/ number and full aperture (a factor in the deterioration of lens performance).

Under these challenging conditions, as a first step toward the realization of this new broadcasting format, utilizing its own optical theory and design technology, adopting new optical materials and improving upon its manufacturing technology, Canon has worked in cooperation with Japan Broadcasting Corporation and succeeded in developing a zoom lens that boasts the SHV system's first tenfold magnification ratio. This zoom lens has virtually zero chromatic aberration or field curvature (loss of resolution at the peripheral edges of an image) at zoom positions from wide to tele, enabling natural and high quality rendering.

Additionally, from a practical application perspective, the lens has been made compact and light, and is powered by a newly developed motor unit, guaranteeing the same high level of operability as conventional high-definition cameras.

Resolution Comparison



SHV has 16 times the resolution power of current HDTV

SHV Resolution Comparison

SHV 10x Zoom Lens

Network Cameras and Remote Video/Recording Software

Monitoring and Recording Remote Video over Networks

Canon's VB series of network camera systems facilitates the easy operation and display of remote video images using a web browser or dedicated viewer software.

● High Image-Quality, Advanced-Function Network Cameras

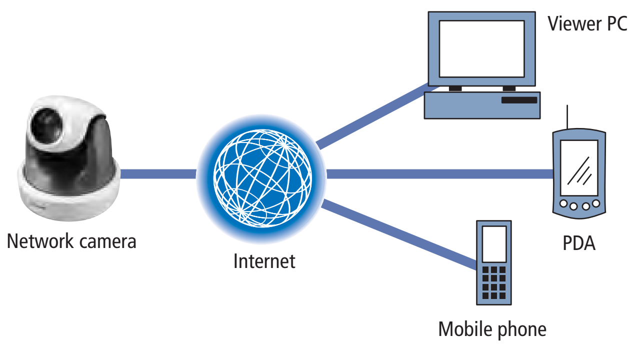
Canon network cameras are capable of transmitting VGA video images (640 x 480 pixels) of up to 30 frames per second to viewers and make possible high-resolution, low-illumination shooting. They include such intelligent functions as motion detection and image uploading, and can be freely operated by remote control via an independent viewer, enabling the shooting of high-impact images completely unlike those made possible with conventional fixed cameras. Additionally, sending images to a small group of viewers or establishing a monitoring system can be done with ease.

The systems use the standard Hypertext Transfer Protocol (HTTP)[*1] to transmit camera-control information and image data, ensuring compatibility with Internet-related software.

● Network Video-Recording Software

Network video-recording software facilitates remote monitoring, enabling video images from up to 64 network cameras to be recorded simultaneously to a single recording server. It also permits the integration of multiple recording servers into a single system. Additionally, because the video monitoring system uses LAN and the Internet, it can be used to set up wide-area security systems or monitoring systems for factories and stores.

The viewer enables the free layout of multiple image displays, providing a sense of intuitive operation. Linking with other systems is also possible through a network connection.



Example of a Network Camera System Configuration

*1 HTTP
Used for sending and receiving content data (HTML) between web servers and web browsers.

Medical Equipment

Canon uses its original optical and digital imaging technologies to supply devices that support digitization and networking in the field of medicine. Canon's digital X-ray systems and ophthalmic equipment, which simplify the diagnosis process, continue to play an increasingly important role in the medical industry.

Digital Radiography System Supporting Both Static & Dynamic Images

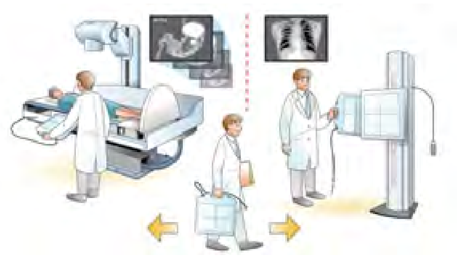
Higher Accuracy in X-Ray Diagnosis with Dynamic Imaging Assistance

Medical diagnosis based on X-ray images is yet another field where digitization is making significant inroads, eliminating the need for film and facilitating on-screen diagnosis. Canon launched the world’s first digital radiography system in 1998. Named the CXDI-11, it featured a proprietary-developed X-ray image sensor, and since then, the company has remained the leader in this field, continually expanding its lineup of related products in response to ever-diversifying demand for X-ray diagnosis solutions.

Newest addition to the lineup is CXDI-50RF, equipped with the company’s newly-developed X-ray image sensor capable of capturing dynamic images. The product caters for both dynamic imaging and the capture of high-quality static images. Thanks to this dual capability, the CXDI-50RF can be used not only to diagnose problems in areas such as the chest and limbs using regular static images, but also to monitor moving image of the digestive system and other internal organs, taking static radiography images as required.

CXDI-50RF is also light weight and portable, in spite of its large imaging area. The wealth of designing and development expertise acquired in the field of portable imaging sensors enabled Canon to realize a digital radiography system that provides for both static and dynamic images in a single, handy package. The CXDI-50RF can be carried about with ease, allowing for highly-flexible, highly-convenient operation. For example, a CXDI-50RF table system can be set up for barium study of the digestive system in the morning, and then in the afternoon, an upright stand system can be set up in a different location for general chest examination.

CXDI-50RF



Typical Example of CXDI-50RF Usage

Mydriatic/Non-Mydriatic Hybrid Digital Retinal Camera

Single Device Supports Both Mydriatic & Non-Mydriatic Retinal Examination[*2]

Canon, with its solid track record in the eye examination devices industry, has introduced CX-1, the company’s first retinal camera[*3] to combine mydriatic and non-mydriatic functions in a single device.

In the past, retinal cameras supporting both types of examination have required special optical systems and sensors for non-mydriatic retinal examination – that is, without dilating the pupil – resulting in highly complex retinal camera designs. In response, Canon integrated optical technologies acquired over many years of experience in the development of SLR cameras, with cutting-edge expertise in the fields of digital imaging and retinal camera technology, to develop CX-1 – a compact, hybrid retinal camera that is uniquely Canon. In addition to high sensitivity and low noise levels, the CX-1 utilizes proprietary image processing technologies to make possible higher resolution and better image quality than ever before, contributing to improved accuracy in diagnosis.

The CX-1 is equipped with five different photography modes, including Color, Red-Free, and Fundus Autofluorescence (FAF). And as the operator can switch between these modes with a single touch of a button on the operation panel, the speed and overall efficiency of retinal image capture is greatly increased. The non-mydriatic, FAF mode of operation in particular has been widely praised by medical community for its ability to reduce both examination time and patient stress.

*2 Mydriatic and non-mydriatic examination
Eye examination using a retinal camera can be carried out either mydriatically, where pupil is dilated using eye drops, or non-mydriatically, where pupil is not dilated. In general, mydriatic exams can provide more detailed information, yet patients may experience intolerance to bright light. A physician decides which exam type to use.

*3 Retinal camera
Used to examine the condition of, and check for bleeding in, the retina and blood vessels at the back of the eye. Plays an important role in the early diagnosis of a variety of eye conditions as well as diabetes.

CX-1

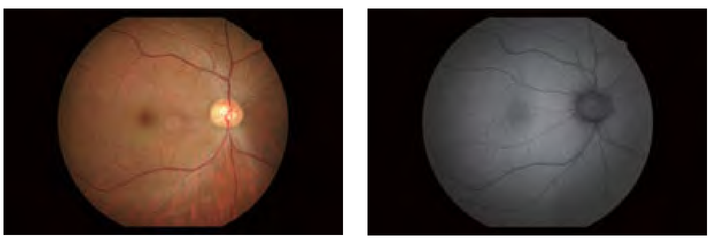


Image of a Healthy Eye Captured by the CX-1 (Left: Color Mode, Right: FAF Mode)

Optical Equipment

The technologies that Canon has developed as an optical equipment manufacturer find application in a wide range of fields. The Subaru Telescope, which sits atop Mt. Mauna Kea on Hawaii, probing the mysteries of the birth of the universe, features a prime-focus corrector lens system that is the pride of Canon's optics and precision technologies.

The Subaru Telescope's Prime-Focus Corrector Lens System

Canon Technology; Supporting New Discoveries in Space

The Subaru Telescope is located on the summit of Mt. Mauna Kea on Hawaii and is operated by the National Astronomical Observatory of Japan. The main feature of the Subaru Telescope is that it is equipped with the world's only 'prime focus' system in an optical infrared astronomical telescope of more than 8 meters in diameter. The unparalleled imaging quality of the prime focus camera*1 installed in the Subaru Telescope's prime focus system continues to deliver astonishing results, and was instrumental in the discovery of a galaxy (IOK-1) some 12.88 billion light-years distant from Earth.

The Subaru Telescope's prime focus can be used to observe a field of view with a wide 0.5 degrees, almost the same as the diameter of the moon and 25 times wider than the field of view of the Cassegrain focus (field of view 0.1 degrees). The lens configuration comprises seven large lenses in five groups, and has a diameter of 520 mm and weighs 170 kg, making it the largest lens unit constructed by Canon.

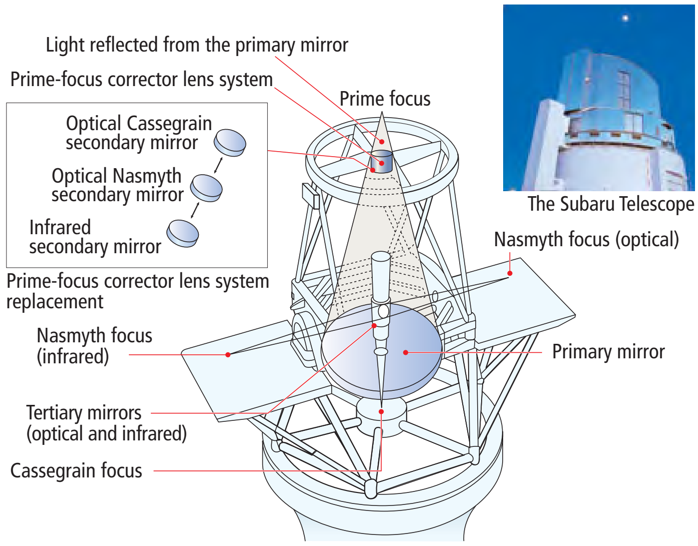
Prime focus allows bright images to be obtained in a wide field of view but, with conventional optical design it proved impossible to attach heavy optical devices to the prime focus of very large telescopes. The answer to the problem was in the 'smaller and lighter' prime-focus corrector lens system and Canon succeeded in developing a compact, high performance lens unit that was smaller in size than the original design by about 70%, and lighter by 50% or more. The manufacture of this optical system represented a crystallization of Canon's technologies in the high-precision polishing of large aspherical lenses and the high-precision machining of lens barrels, as well as Canon's advanced assembly technology.

Furthermore, the lens unit is able to correct atmospheric dispersion*2 with a high degree of accuracy. This is done via a Canon original system using two lenses of materials with differing dispersion characteristics which are shifted at right angles to the optical axis to correct the atmospheric dispersion.

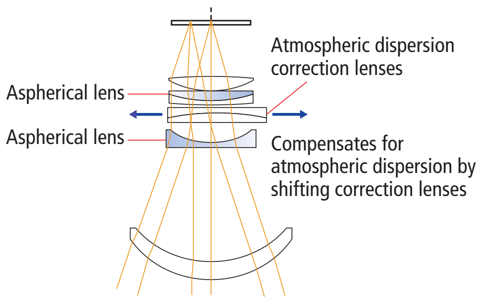
Today, it is believed that dark matter, which accounts for roughly 23% of the universe, holds the key to the birth of the universe, and that dark energy, which accounts for roughly 73% of the universe, will determine the future of the universe. Therefore, understanding the true nature of these as yet unknown elements is one of the most important issues in the fields of astronomy and physics.

The National Astronomical Observatory of Japan is working together with Tokyo University's Institute for the Physics and Mathematics of the Universe in its plan to discover the true nature of dark matter and dark energy. The project calls for the Subaru Telescope to be fitted with a new prime focus camera that will enhance the field of view from the current 0.5 degrees to 1.5 degrees, in order to observe multiple galaxies in a short space of time, including distant and dark galaxies, and to make precise measurements of the dimensions of these galaxies. Also, by using the gravitational lens*3 effect, an attempt will be made to render a 3D map of dark matter, and to investigate the true nature of dark matter and dark energy.

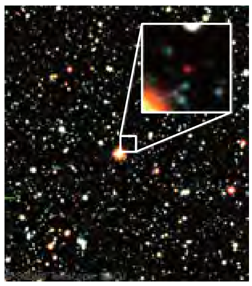
Canon is currently working to support this project by utilizing further evolved large scale precision optic system design and manufacture technologies, and working to develop a new prime-focus corrector lens system that will feature a new prime focus camera.



Design of the Subaru Telescope



Prime-Focus Corrector Lens System



The red galaxy visible in the center of the enlarged view is IOK-1

(Source : National Astronomical Observatory of Japan)

Galaxy IOK-1 Lies 12.88 Billion Light-Years from Earth

*1 (Subaru Telescope) prime focus camera
Also known as 'Suprime-Cam'. A CCD camera equivalent to an 80-megapixel digital camera.

*2 Atmospheric dispersion
A phenomenon in which, the light from stars appears blurred due to the differences in refractive indices of the atmosphere by wavelength, when the light reaches the Earth's atmosphere.

*3 Gravitational lens
A phenomenon whereby the light from stars, galaxies and other astronomical bodies appears bent and distorted by the gravitational pull of other astronomical bodies on the light path, and where multiple images can be observed.

Display Devices

The demands and requirements placed on display devices are becoming ever more diverse and, in order to answer these demands, Canon is bringing into play its ultra-high processing technology and materials technology, as well as its electronics technology, all based on the pursuit of the highest image quality, in order to advance the development of display devices.

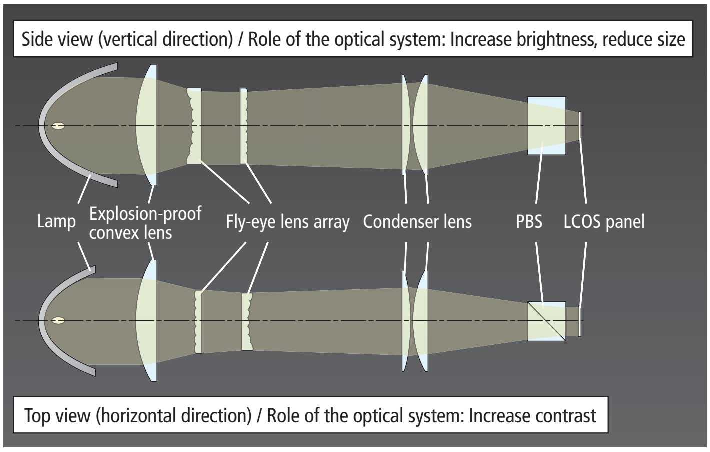
AISYS (Aspectual Illumination System)

A New Optical System Featuring a Partnership of Compact Size and High Image Quality

For the image display devices*4 of liquid crystal projectors, Canon builds and mounts its own reflective liquid crystal panels, LCOS (Liquid Crystal On Silicon). Although LCOS panels are ideal for displaying high-resolution images, because they must be used with a polarization beam splitter (PBS), achieving brightness in a compact body design meant sacrificing contrast. Canon took on the challenge of solving this problem by developing the unique AISYS optical system.

When the AISYS illumination optic system converges light from the light source, it independently controls the light in both the vertical and horizontal directions. The light is converged at a larger angle in the vertical direction in order to increase brightness, and at a smaller angle in the horizontal direction in order to prevent light leakage*5 in the PBS and LCOS panels, thus improving contrast.

AISYS has now evolved into its third generation, which features multiple lenses arranged vertically and horizontally into the newly developed concave fly-eye lens*6 as well as a new optical design that greatly reduces the number of lenses used and achieves reduced size and cost while enhancing brightness and maintaining high contrast performance. In addition, the use of a projection lamp with high color rendering performance and design that takes account of the sensory characteristics of the human eye, Canon has been able to realize ever more faithful color reproduction. And, Canon's switch to the in-house development of LCOS panels has meant that all key liquid crystal projector parts, such as AISYS, projection lenses, LCOS panels and driver ICs, are now developed in-house.



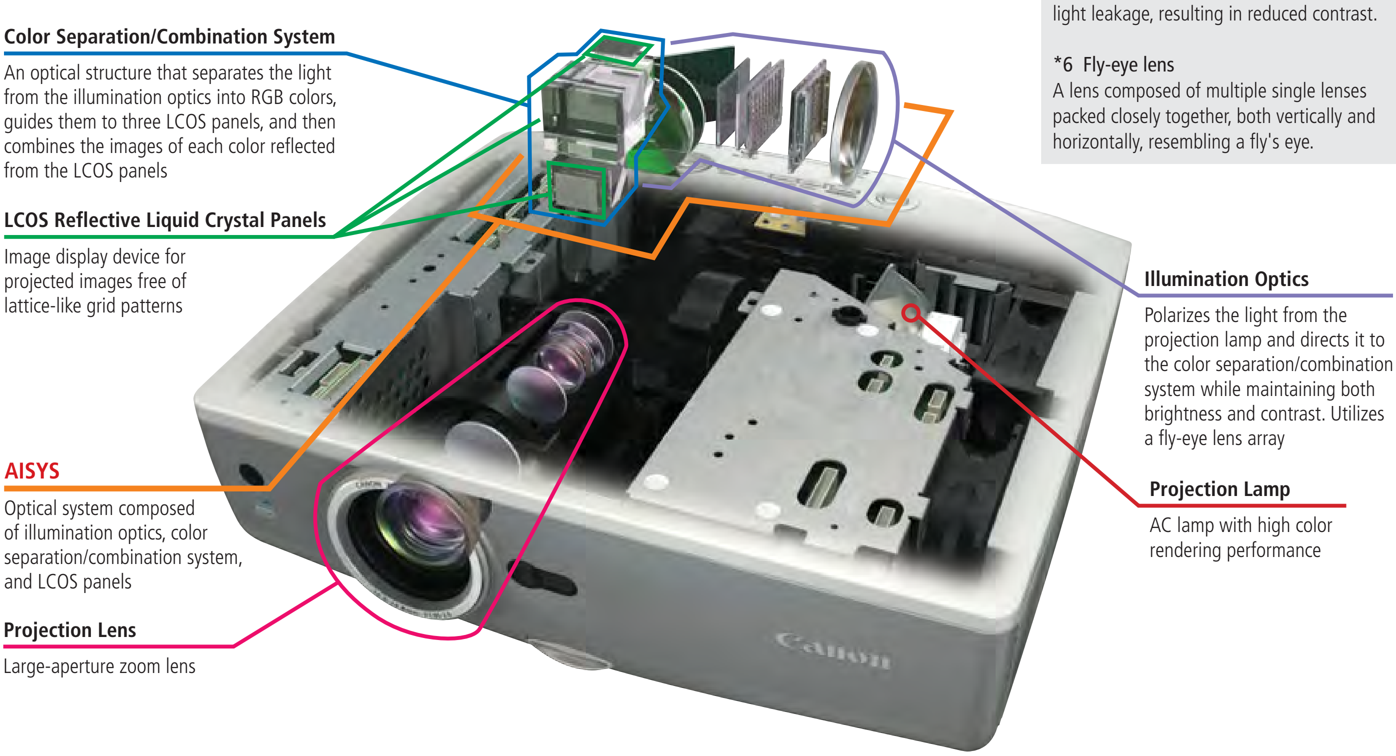
Overview of the Third-Generation AISYS Illumination Optical System

Fly-eye Lens

*4 Image display devices
Liquid crystal panels can be either transmissive or reflective. Since drive circuits lie between the pixels on transmissive panels, a grid-like pattern appears in the projected image. With reflective panels, the drive circuits are behind the liquid crystal elements, enabling the panel to project a smooth, seamless image.

*5 Light leakage
Because of the polarization characteristic of the LCOS panels and the PBS, light beams entering at a high angle of incidence can cause light leakage, resulting in reduced contrast.

*6 Fly-eye lens
A lens composed of multiple single lenses packed closely together, both vertically and horizontally, resembling a fly's eye.



Liquid Crystal Projector Optical System

MR (Mixed Reality) Technology

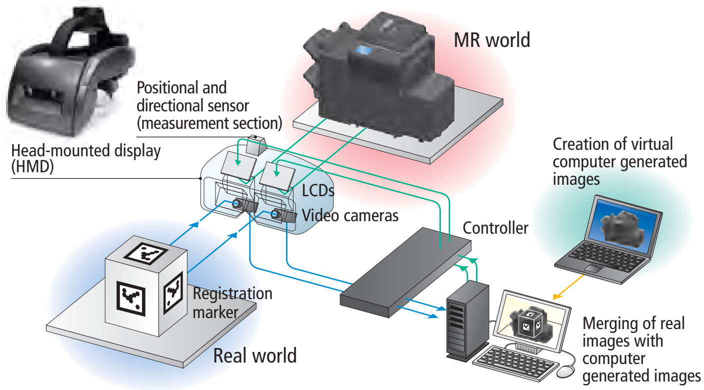
Merging the Real World with the Virtual One

MR technology refers to imaging technology that seamlessly integrates the real and virtual worlds in real time. MR benefits from the individual advantages of both the real and virtual worlds with much more realism than current VR technology. With numerous achievements in the field, Canon has been working on the application of MR technology through the development of the company's head-mounted display (HMD) and registration and calibration technologies.

As a key MR technology device, the video see-through HMD, which incorporates two compact built-in cameras, eliminates the parallax that would occur between the lines of sight of the observer and the camera for each eye. When wearing the HMD, virtual objects generated with computer graphics appear to exist in real space, enabling the observer to easily grasp the scale of the virtual objects within real-world surroundings.

Two CCD cameras installed inside the HMD capture video images from the real space for both the right and left eyes, and the real video images are input into a computer. At the same time, sensors are used to measure the position and orientation of the HMD and, based on this information, the computer generates and overlays computer graphic images onto the captured real video images. Using the freeform prism developed as a result of Canon's advanced technologies, the images on the miniature LCDs are then enlarged to display a composed stereo video image.

MR technology is expected to be applied in various areas, such as for design simulations and prototype-less development, in addition to various fields including medical diagnosis and surgery assistance, education, exhibitions and entertainment.



Overview of MR Technology

SED (Surface-conduction Electron-emitter Display)

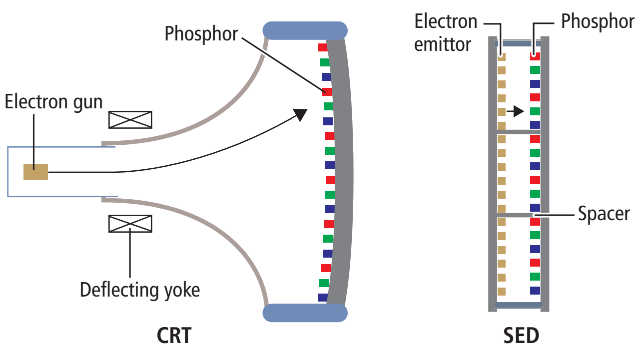
Realizing High Image Quality on Large Screens with Low Power Consumption

In a Surface-conduction Electron-emitter Display (SED), which is a type of flat-screen display, electron emitters fulfilling the role served by the electron gun in a cathode ray tube (CRT) are distributed in a number equal to the number of pixels on the display. The space between the two electrodes in each electron emitter is an extremely small gap of just several nanometers.*1 When voltage is applied between the electrodes, electrons are emitted from one side, and some of these electrons are accelerated by an additional voltage applied between the glass substrates, resulting in luminescence when the accelerated electrons strike the phosphor.

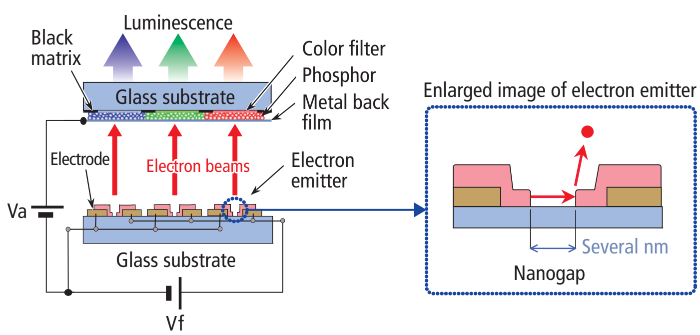
While maintaining the same level of video responsiveness and high contrast as the CRT format, the SED features high luminance efficiency and low power consumption in addition to beautiful image quality not affected by distortion on a large screen. Canon is working on development to further advance technologies of this ideal display.

*1 nanometer (nm) : 1 nanometer = 1 billionth of a meter

SED (Prototype)



Comparison of CRT and SED



SED Structure

Organic Light Emitting Diode Displays

Toward More Convenient Mobile Devices

OLED displays are self-emitting displays based on the phenomenon of organic electro-luminescence, which occurs when voltage is applied to excite organic materials between two electrodes. They have high image quality and are light and compact, with low power consumption, making them attractive for use as displays in mobile telephones and other portable devices.

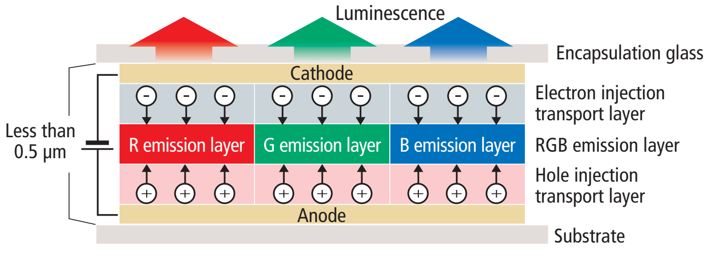
Canon, aiming to realize high performance, low-cost OLED displays, carried out the development process in-house, from organic materials to devices and processes.

To develop the organic materials, Canon applied the principles of the organic photo-conductors that it had developed for use in the field of electro-photography and further developed electron injection transport materials, as well as dopant materials and RGB light-emitting materials for increasing emission performance.

The system adopts a "top emission" structure that casts light to the encapsulation layer side, ensuring a wide aperture ratio to enable highly efficient light emission. Because organic films are color-coded using high-precision mask deposition technology to ensure that RGB luminescent materials emit light for each color, color filters and color conversion are not required. Active matrix TFT substrates are used to drive the pixels.

In terms of manufacturing technology, Canon is working closely with Group companies Canon Anelva and Tokki, who have developed vacuum processing technologies, and is also collaborating with Hitachi Displays in order to produce OLED with high levels of efficiency, color purity, and longevity.

OLED Display (Prototype)



Structure of OLED Display

Group Company Technology —— Tokki Corporation

OLED Manufacturing Device Technology

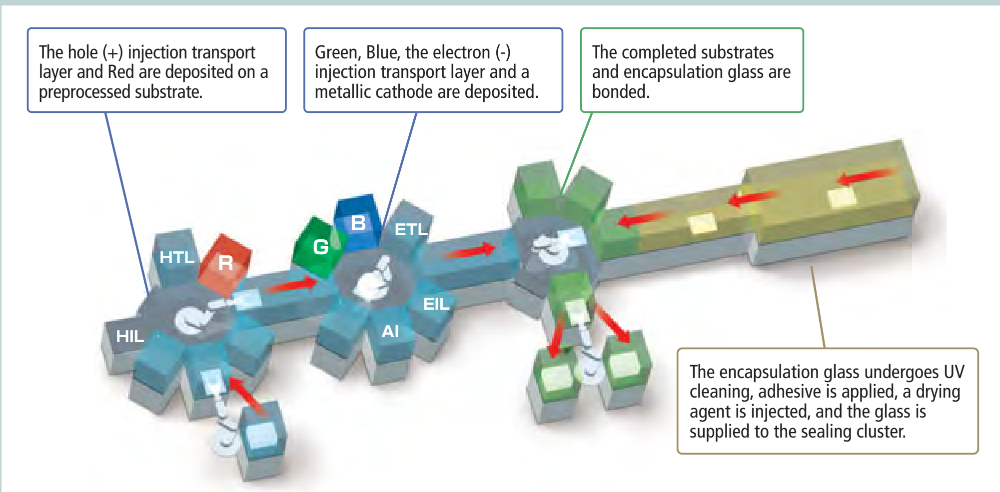
Mass Producing OLED Displays

Because the organic material used to manufacture OLED display panels easily deteriorates when brought into contact with moisture or oxygen, it is necessary to coat RGB emission layers and metallic electrode material in a vacuum using vacuum deposition, then seal the organic material without exposing it to air. Tokki, a Canon Group company, develops and manufactures cluster-type and other OLED panel manufacturing equipment for the complete automation of all panel manufacturing processes.

The coating process is performed with high-precision mask deposition technology using a proprietary mask alignment mechanism that employs a CCD camera. The organic material is deposited through evaporation, and the film thickness is optimally controlled by an evaporation-rate control system. Because high temperatures of around 1,000°C are necessary for the deposition of metallic electrode material, a high-temperature cell evaporation source is used.

In the encapsulation process, a low-humidity, low-vacuum pressure chamber near to atmospheric pressure is filled with nitrogen gas and adhesive is applied.

This fully automated manufacturing system can maintain constant operation with a cycle time of 2–5 minutes per substrate for approximately one week, contributing to the mass production of OLED displays.



Fully Automated OLED Display Manufacturing System

Common Platform Technologies

As network environments evolve, IT continues to advance at a rapid rate. To keep pace, Canon is working to build a platform for digital technologies structured by core technology in the IT field. Sharing these cutting-edge digital technologies among various products, the company achieves faster product development and improved quality. Some of Canon's devices are used as industrial components in research institutions and production lines both in-house and outside the company.

Color Management Technology

Achieving Unified High-Quality Color Across Devices

As input and output devices differ in the range of colors that each is capable of reproducing, the colors appearing on displays and in printout have not always been consistent with the colors of the original input image.

Canon has been engaged in activities to achieve high image quality and consistent color reproduction performance in various input and output devices. The company has accumulated a wealth of expertise in image management, evaluation and simulation technologies, as well as in image processing technology. This expertise is put to use to accurately reproduce colors true to the original, to assign quantitative values to preferred colors, and to establish target colors as Canon Unified High-Quality Color. The company has also developed design and evaluation tools to achieve such goals, and has created an integrated image-development environment.

The Canon Unified High-Quality Color is currently being used in almost every category of Canon imaging device. Canon has further developed this technology to create Kyuanos, a high-accuracy color management system (CMS). This system achieves accurate color matching with reduced color differences by taking into account such factors as lighting conditions, print media characteristics, and so on which can have a significant impact on how colors appear.

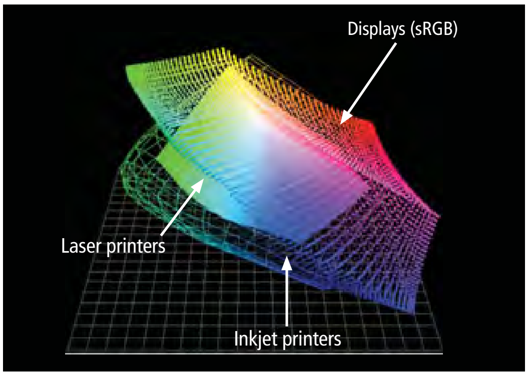
● Kyuanos

High-Accuracy Color Management System

Accurate color matching requires a device profile (or color design data) for each input/output device combination and paper media. Conventional technology demands a tremendous investment of time and effort for the creation of these profiles. With Kyuanos, however, profiles can be set up automatically, making it easy to achieve high-accuracy color matching that satisfies professional requirements. The color reproduction range of input and output devices has expanded in recent years, making it difficult to correctly reproduce colors using the conventional 8-bit and sRGB standard color space.

Kyuanos offers an extended color space for 16-bit and 32-bit formats that allows for maximum input and output performance without color space restrictions. This enables the reproduction of exceptionally vivid colors with rich gradation.

Another feature of Kyuanos is the support for different lighting environments. Kyuanos is able to numerically convert colors based on human perception, lighting characteristics that significantly affect how images appear (for example, whether fluorescent or incandescent lighting is being used), and the color reproduction characteristics of the device in question. Using this data to convert images enables color consistency even under different lighting environments.



Differences in Color Reproduction between Input and Output Devices

Without Kyuanos:
Poster colors look different under different lighting

Kyuanos

With correction for ambient light by Kyuanos:
Poster colors look identical even under different lighting

Difference in How Posters Look with Kyuanos

Communication Network Technology

Achieving Connectivity for Digital Devices

Canon is currently developing communication network technologies that provide a cross-media communication environment in which input/output devices such as printers and digital cameras can easily be connected to a network, anytime and anywhere.

● Wireless Communication Technology

Wireless communication technology provides a high-speed communication environment that can be used anytime and anywhere.

Canon has been working on improving communication performance by focusing on the development of ways to embed such standard communication technologies as Wireless LAN (IEEE802.11b/g/a/n) and Bluetooth into cameras, printers, and other products. Now developed as a common platform, this technology has been optimized for and implemented in Canon products.

Other activities that Canon is working on include the development of public wireless technologies, next-generation wireless technologies and middleware to provide easier and more secure wireless connections, and the standardization of wireless technology.

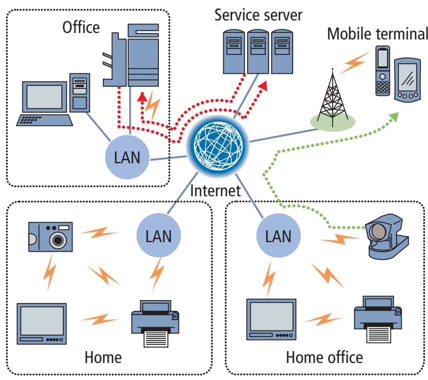
● High-Speed Video-Communication Technology

Transmitting video images among networked devices requires technologies capable of controlling signals affected by external factors and transmission quality. Canon's high-speed video-communication technology enables the networking of high-definition video images and high-quality audio signals, and also facilitates high-speed transfer while preserving high-definition image quality.

Through the use of this technology, the company is working on the development of technologies to provide a more lifelike communication experience among remote locations over a network.

● Device Automatic Connection Technology

Automatic connection technology includes standards such as DLNA[*1] and directory services.[*2] However, these standards are often incompatible and it is difficult even for devices using the same standard to automatically connect over wide-area networks such as the Internet. Canon is working to create a system for interconnecting a variety of input and output devices, and working on the development of communications software for automatically connecting devices using different standards over a wide-area network with the aim of quickly resolving inconveniences faced by users.



Schematic View of Wireless Communication and Device Automatic Connection Technology

*1 DLNA (Digital Living Network Alliance)
DLNA refers to both an organization and guidelines for promoting standardization for the exchange of data between home appliances, mobile devices, PCs, and other electronic equipment.

*2 Directory service
A directory service is a network management system that, among other functions, enables users to manage and search for positional information of devices connected to a network.

XML Technology

Promoting Logical Data Compatibility

XML is a markup language[*3] used as a format for providing logical data compatibility to simplify the sharing of structured documents and data between different information systems. It has become more familiar in recent years for its use in terrestrial digital broadcasting data and map data used by the Geographical Survey Institute. While working to address the challenges of improving XML processing performance in products, Canon is developing XML technology with an eye to the future.

● Binary XML Technology

Binary XML technology is a technology that expresses text-based XML in a binary format that computers can directly understand. Binarization, which reduces the size of XML to less than 20% of its original size and boosts performance by at least five times, is essential when using XML in compact products. However, because each manufacturer uses a different binarization method, interoperability, which is one of the benefits of XML, is sacrificed.

Canon is promoting the formulation of standard binary XML specifications by the W3C,[*4] which is expected to prevail in the near future. The company is also developing methods for compression and encoding of structural patterns optimized for XML data used in such areas as 2D graphic language, and is working to apply these to maximize XML processing performance in Canon imaging devices.

● Technologies Linking Web Applications

Many services, such as map and photo-sharing, are now provided as web applications.[*5] Web applications use a standard web interface called the Atom protocol to send and receive contents.

Canon is developing software to enable products such as MFPs and digital cameras to communicate directly with web applications using the Atom protocol. The company will continue to promote services that integrate devices with the Internet while working to support such security functions as electronic signatures, encryption, and user authentication in XML.

*3 Markup language
Markup languages describe the meaning and structure of documents and data by embedding specific text strings called "tags". Other markup languages include HTML and SGML. XML is derived from SGML.

*4 W3C
The W3C, or World Wide Web Consortium, is an organization promoting the standardization of technology used on the WWW.

*5 Web application
Web applications are programs that use web functions. When a user makes a request, the server provides a mechanism that generates and provides content.

Image Retrieval Technology

Searching for Similar Images and Video Clips

The widespread popularity of digital cameras and video camcorders has led to more opportunities to shoot and store digital photos and video, a greater number of exchanges over the Internet, and increased database usage. Canon's image retrieval technology enables users to quickly and accurately search the image out of large volume data without the need for keywords to be recorded in advance.

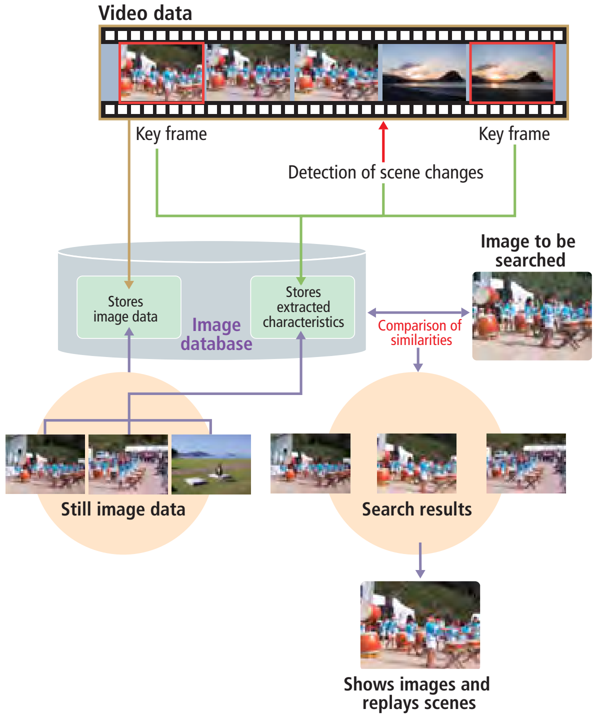
● Image Retrieval Technology

Image retrieval technology facilitates the searching of similar images from an image database. Users perform a search by first selecting a still image, and by then setting priority levels for three characteristics – color, pattern regularity, and composition. As such, a wide range of different search methods are made possible. Furthermore, this technology also allows large volumes of data to be searched for images of different sizes as well as images captured from different angles. Search results are displayed as a list so that they can be narrowed down in order to quickly locate the desired images.

Canon has also incorporated this technology into imageWARE Secure Audit Manager (→ P.46) so that sources of leaks can be identified from user information concerning print, copy, and fax jobs and from image characteristics.

● Video Retrieval Technology for Similar Images

Through advances in image retrieval technology, the system can detect any number of scene changes, even with scenes containing rapid changes, and automatically generate the corresponding number of representative key frames. When a video clip (represented by a still image) is selected for searching, key frames from similar video clips are identified and the results are displayed, enabling users to quickly find specific scenes even out of large volumes of video image data.



Overview of Still-Image and Video Retrieval Technology

User Interface (UI) Platform Technology

Highly-Visual, Intuitive UI

UI technology for improving operability plays an important role in bringing out the function and performance potential of devices to differentiate products from those of competitors. As functions become more enhanced and more diverse, Canon is developing technology for progressive and easy-to-use UIs to make products more competitive. The company is also working on creating an environment for more efficient designs, such as technology to speed up the product-development process.

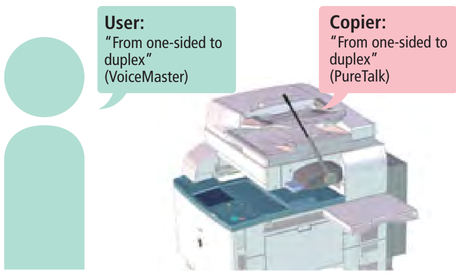
● SVG UI Technology

SVG[*1] is a vector-based graphic format. Using this technology, Canon aims to provide more-attractive graphical user interfaces (GUI) that are also easier to use. In addition to graphics- and text-rendering capabilities, SVG also incorporates filter effects for blurring and shading graphics, and animation features for altering the position and color of graphics in response to the passing of time. Canon is making use of these characteristics to develop next-generation UI technology with high levels of expression, such as animation-based visual effects and scalable displays irrespective of display size.

● Speech UI Technology

As voice- and speech-based user interfaces become evermore prevalent, Canon provides environments for automatic operation that responds to the user's voice and for operating products in line with voice guidance. In this way, the company aims to improve operability to make for products that are more user-friendly.

Already incorporated into network MFPs and the like, Canon's speech-recognition engine can accurately recognize voice commands with no need to register the user's voice in advance. It is unaffected by ambient noise and represents the industry's highest achievement in speech-recognition performance. Moreover, the company's speech-synthesis engine for converting text to voice provides the industry's most natural and clearest voice synthesis in the field of embedded products.



Operating a Copying Machine with Speech Recognition and Voice Guidance

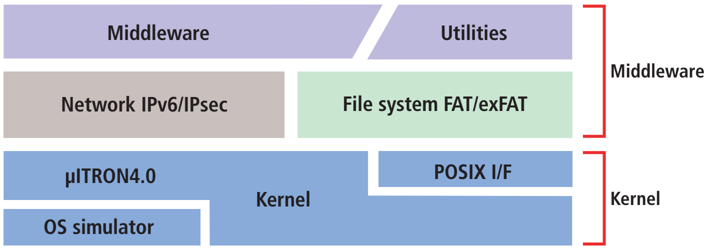
*1 SVG (Scalable Vector Graphics)
SVG is a vector graphics format, as opposed to a raster graphics format such as GIF and JPEG in which images are composed of a grid of pixels, or points. SVG is an XML-based markup language for quantitatively describing such geometrical shapes as Bezier curves and rectangles as vector graphics. The format allows graphics to be resized freely without deteriorating image quality. Additionally, colors and shapes can easily be altered simply by rewriting part of the markup description.

DRYOS

Real-Time Embedded Operating System

DRYOS is an embedded real-time operating system*2 developed by Canon for use in compact devices and employed in a wide range of company products such as digital cameras and digital video camcorders. The kernel*3 module, which represents the heart of the system, facilitates customization to meet the needs of device and hardware resources, and it features a flexible structure that can be expanded in size from a minimum of 16 KB. It currently supports more than 10 types of embedded CPUs, and by supporting the use of an OS simulation development environment on PCs, makes it possible to develop software products without the need to operate them on prototype devices.

In response to demand for ever more multifaceted digital products, Canon has also developed various kinds of middleware for file systems and the TCP/IP network stack,*4 in addition to device drivers to support USB and the like. By developing platform software in-house, the company can promote the reuse and sharing of software modules while quickly addressing the trend toward high-performance, high-functionality devices.



DRYOS Module Hierarchy

*2 Real-time operating system
An operating system that processes in real time. Such operating systems are often embedded in devices.

*3 Kernel
The core part of an operating system that manages system resources such as the CPU, memory, and peripherals, and provides basic functions to ensure that hardware and software run efficiently.

*4 TCP/IP network stack
A suite of software needed to work with the TCP/IP communications protocol for interfacing with the Internet.

System LSI Integrated Design Environment

Ensuring Efficient Development of Large-Scale System LSI

Canon develops its own system LSIs,*5 single-chip ICs that contain all system components, including the hardware and software necessary to run the device. These system LSIs are tiny chips of only several square millimeters or centimeters, but they contain extremely large systems and are important components that determine product functions. Since the 1990s, Canon has been ahead of other companies in the development of system LSIs, developing LSIs such as DIGIC (→ P.29), the iR Controller (→ P.43), and L-COA (→ P.38), to reduce the size and increase the functionality of products.

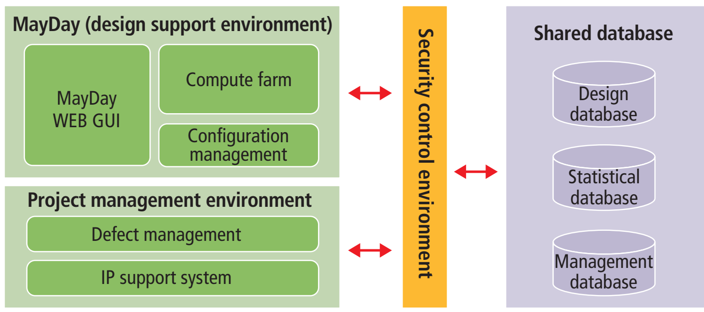
Development of LSIs combining multiple functions requires collaboration among many engineers and an efficient development environment. Canon has developed a highly efficient system LSI integrated design environment that consolidates the entire development process, from specification study to physical design.

● Design Support Environment

To support LSI design, Canon has developed MayDay, a unique design support tool. MayDay, an easy to understand web-based tool, supports communication and job progress for each member of a development team, which may include several hundred people. The compute farm underlying MayDay automatically activates the tool, managing a license pool for numerous CPUs and tools, and distributes the appropriate computing servers and licenses according to the demand for such resources. Configuration management allows the easy reuse of design assets by making possible the management of design-results files and entire directories needed for compilations and simulations.

● Project Management Environment

The project management environment targets personnel such as designers and project leaders. Defect management enables the sharing of bug information for each project and linking to development flows, with multi-conditional search and tracking features. In the IP*6 support system, functions that can be shared among multiple products are registered in a database as programs (IP core). Promoting the reuse of registered IP cores reduces the number of support processes and helps shorten development time.



Overview of System LSI Development

*5 System LSI
A System LSI is a large-scale integrated circuit that contains functions provided by the CPU, memory, and dedicated LSI on a single chip. System LSIs realize faster operation because there is no need for the wiring required when using multiple chips. Furthermore, the area taken up on a circuit board is reduced, making it possible to reduce the size of the circuit board, resulting in a more compact device.

*6 IP : Intellectual Property

In-Process Visualization Technology

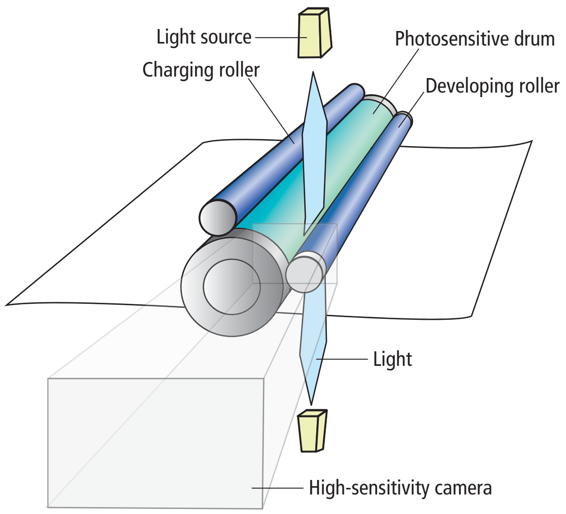
Analyzing Device Operating Mechanisms

In-process visualization technology enables the direct observation (optical observation) of the processes that take place within actual devices to reveal their operating mechanisms. This technology has been useful in revealing toner development and fixing processes, in addition to the ink-ejection process, in Canon products and has contributed to product design and technological innovation.

The diameter of a single toner particle in a laser printer or digital MFP is several µm,*1 and the volume of a single ink droplet in an inkjet printer is 1 pl.*2 In addition to being exceptionally small, they also move at incredibly high speeds, making it very difficult to accurately track them. Furthermore, because these phenomena occur in narrow spaces deep within products, simply viewing them poses a challenge. Advanced technologies including the creation of sample devices, shooting with ultra-high-speed cameras, and image analysis are used to observe the phenomena.

● Visualizing the Toner Development Process

This visualizing technology is used to observe toner particles as they fly towards the photosensitive drum. Based on these observations, engineers can analyze the movement and regularity of toner flying minute distances, which enables the clarification of mechanical positioning and optimal control voltages.



Overview of In-Process Visualization Technology for Toner Development

● Visualizing the Toner-Fixing Process

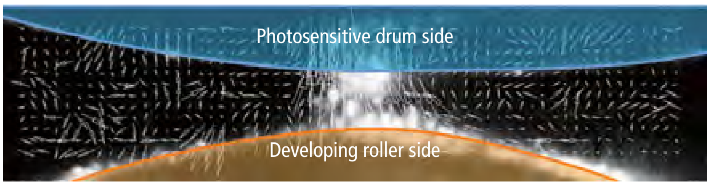
Using an observation device, Canon is able to view the melting, expansion, and re-hardening of toner on the fixing component. Simulations performed by incorporating mechanical data measuring temperature, pressure, and displacement have contributed to the development of fixing-mechanism components and an understanding of the behavior of the toner itself.

● Visualizing the Ink Droplet Ejection Process

Because the ink-ejection process takes place at ultrahigh speeds under which the time from ejection to fixing on paper is less than 1/10,000 of a second, Canon has developed analysis technology combining spatial analysis capabilities at a scale approaching the wavelength of light with time analysis capabilities at the one-millionth of a second level.

*1 µm (micrometer) : 1 µm = one millionth of a meter

*2 pl (picoliter) : 1 pl = one trillionth of a liter



Visualized toner particles flying towards the photosensitive drum

Visualizing the Toner Development Process

Simulation Technologies

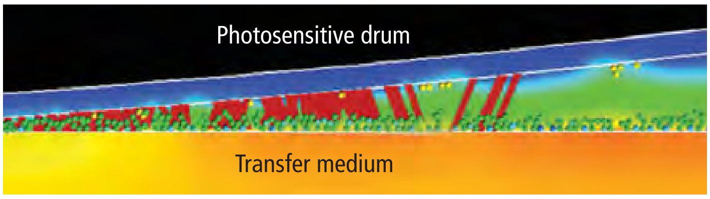
Analyzing Phenomena to Predict Product Performance

During product development, simulation technologies used to analyze phenomena and predict product performance support technological research and enable the shortening of development times.

● Simulating the Electrophotographic Process

The electrophotographic process used to form images in laser printers and digital MFPs consists of charging, exposure, latent image, development, transfer, fixing, and cleaning. Each of these processes, vital for forming images, entails multiple and complex phenomena that until now were difficult to model mathematically.

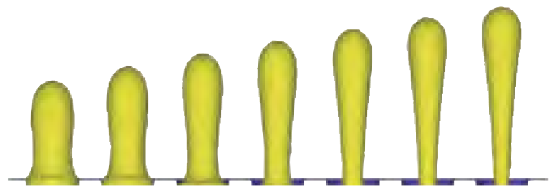
Canon developed its own simulation technologies for these electrophotographic processes, enabling technological innovation and ensuring improved product-development efficiency.



Example of Simulated Transfer Process for Digital MFPs

● Simulation of Inkjet Heads

When developing inkjet print heads, the structure of the nozzles, which ensure the optimal ejection of ink droplets, is a critical design point. Canon developed a simulation program for calculating ink ejection phenomena, which was then applied successfully to calculate ejection behavior based on nozzle structures and drive conditions. The program has made it possible to identify the relationship between nozzle structures and ejection characteristics before prototyping, enabling the short-cycle development of high-performance print heads.



Simulation of Ink Droplet Ejection

New CMOS Sensor

An Image Sensor Providing the Ultimate Sensitivity and the Ultimate Resolution

Canon's CMOS sensors filled with the world's leading technology are core devices providing cutting-edge image processing technology and giving Canon's products the ability to compete on the front line. Their advantages are continuously increasing by pursing all performance indicators required of CMOS sensors, such as dynamic range, resolution and sensitivity.

● Wafer-size*3 CMOS Sensor

When shooting with digital cameras and digital video cameras, the necessary exposure for a subject with a certain level of brightness and an image sensor (CMOS, CCD, etc.) with a certain level of sensitivity is determined by the exposure time and the lens aperture (f/ number). However, it is not uncommon for the appropriate exposure not to be reached in cases where a flash cannot be used in a dark room or at night. This is even more pronounced with video due to restrictions on exposure time.

In such cases, it is necessary to increase the sensitivity of the camera, and sensor size has a significant impact on sensitivity. Increasing the sensor size is an extremely effective way of maximizing the amount of light captured in low light environments.

Based on the device technology it has developed to date, Canon has succeeded in developing a wafer-size CMOS sensor. With a chip size of approximately 20 cm, this is the largest CMOS sensor that can be made from a single 12-inch wafer. Its size is several hundred times that of the CMOS sensors used in standard digital cameras and digital video cameras. Canon utilized an ingenuous circuit design to resolve the issue of signal transmission latency that is a problem in large sensors and succeeded in producing an enormous CMOS sensor.

The actual sensitivity is so high that it is possible to shoot video at 60 frames per second with a mere 0.4 lux of illumination, enabling shooting with 1/100 of the light required when using a full-frame 35mm CMOS sensor.

Possible applications for fully utilizing the potential of this wafer-size CMOS sensor offering the ultimate sensitivity include shooting video of the stars and nocturnal animals, in addition to night surveillance cameras.

Size Comparison of the Wafer-Size CMOS Sensor (Left) and a Digital SLR Camera (Right, EOS REBEL T2i / EOS 550D)

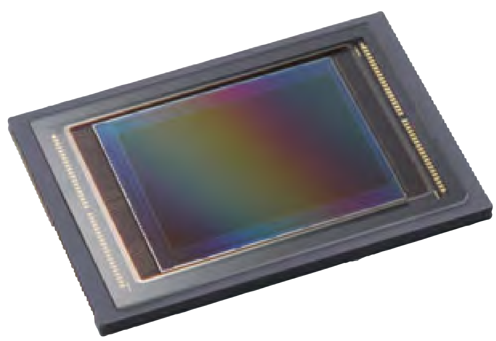
*3 Wafer-size
In recent years, the standard size of a wafer in semiconductor manufacturing is a diameter of 12 inches (approx. 30cm), and the largest chip size that can be produced from such a wafer is approximately 20cm.

● 120-megapixel CMOS Sensor

One of the factors determining image quality is the resolution of the image sensor. A higher resolution enables images to be taken with higher definition and a greater level of expression.

Canon, which has been working on its own CMOS sensors as image sensors for digital SLR cameras for more than ten years, developed a 50 megapixel CMOS sensor two years ago. The company has now succeeded in developing an astounding CMOS sensor with a total of 120 million pixels each with a size of just 2.2μm. Increasing the number of sensor pixels rapidly increases the amount of data per frame, but this sensor supports up to 9.5 frames per second even when used for still images.

Cases in which an ultra-high resolution CMOS sensor could exhibit its potential include taking photos of greatly enlarged posters and partially zoomed shooting using trimming or electronic zoom functions.



120-megapixel CMOS Sensor

Encoders

Accurately Detecting Movements on a Nanometer Scale

Encoders are sensors that measure the angle of or distance traveled by an object by attaching a scale to the target object and counting the scale. Canon has developed ultra-precise, ultra-accurate encoders using cutting-edge optical measurement technology.

● Laser Rotary Encoders (LRE)

Laser rotary encoders detect angles using light analysis*1 and interference,*2 employing semiconductor lasers as the light source. The use of proprietary prism optics enables the creation of more compact devices. LREs are used to adjust the angle of industrial robot arms and camera platforms for broadcasting cameras.

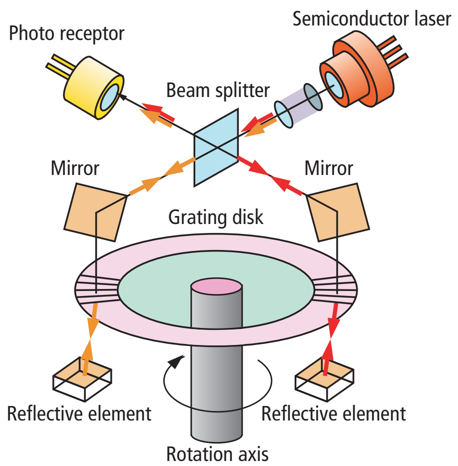
● Micro Linear Encoders (MLE)

Micro linear encoders, which use a unique light reflection-diffraction interferometer with LEDs as a light source, realize ultra-long life spans and an ultra-compact size. When used with a 1,000-part splitter, they achieve a maximum resolution capability of 0.8 nm.*3 MLEs are used in stage sensors in semiconductor lithography tools, hard disk inspection equipment, and semiconductor measuring equipment.

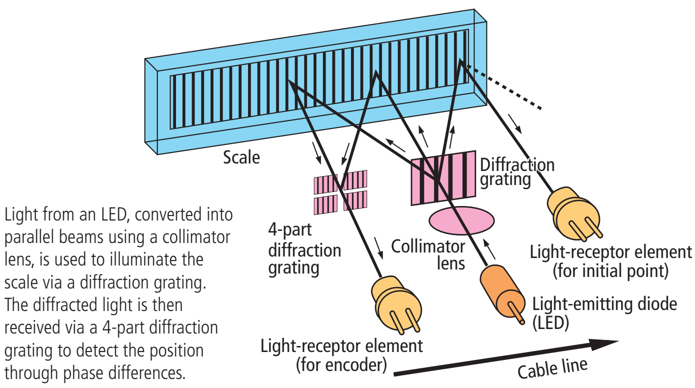
*1 Light analysis
A property of light. Light travels in waves which, upon striking an object, curve around into the shadow of the object. This phenomenon is known as diffraction.

*2 Interference
A property of light. Light travels in waves and becomes brighter when combined with light of the same phase. When combined with light with a phase that differs by 180 degrees, the two will cancel each other out, resulting in darkness. This phenomenon is known as interference.

*3 nm (nanometer) : 1 nm = one billionth of a meter



Operating Principle of Laser Rotary Encoders



Overview of MLE

Laser Doppler Velocimeter

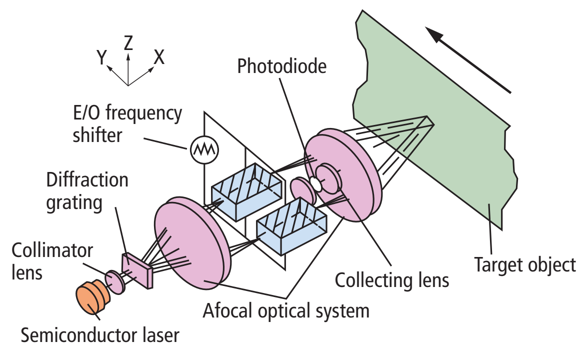
Noncontact Precise Detection of Velocity Inconsistencies and Rotation Inconsistencies

A laser Doppler velocimeter is a device that measures the velocity of a moving or rotating object without coming into contact with the object by illuminating it with a laser through an afocal optical system.*4

Laser light is converted into parallel beams using a collimator lens and split using a diffraction grating. Two lights with different frequencies created by an E/O frequency shifter (an element that shifts the frequency) are used to illuminate the measured object, and the scattered light is passed through a collecting lens to be read by a photodiode. The velocity is then measured based on the beat signal (Doppler frequency) of the light obtained. The system enables the measuring of speeds from a state of rest to -200 to 2,000 mm, -50 to 5,000 mm per second. The technology is used in R&D and production lines for detecting paper transport speeds and velocity irregularities in printers and digital MFPs, detecting rotation irregularities in photosensitive drums, and detecting rotation and feed inconsistencies in the drive units of machine tools.

*4 Afocal optical system
An optical system without a focal point (infinite focal length), in which the same parallel light that enters the lens also leaves the lens. The system is used in telescopes and beam expanders (an optical module for expanding the beam diameter of laser light).

Laser Doppler Velocimeter



Overview of Laser Doppler Velocimeter

Galvano Scanner

Achieving Advanced Laser Processing

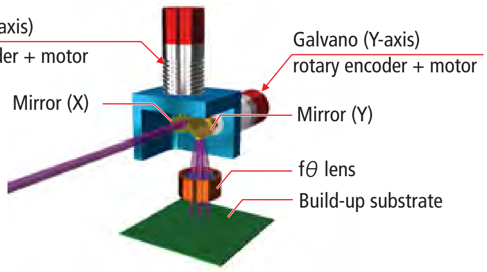
Laser-processing machines are devices that rotate mirrors at high speeds to determine the position of laser light to perform boring, cutting, and trimming processes.

Canon's galvano scanner,*5 which utilizes proprietary encoder technology, is a high-precision laser scanner incorporated into laser processing machines. Combined with fully closed digital servo technology to provide optimal control in accordance with the application, the scanner detects mirror angles. Galvano scanners provide excellent positioning precision and repetitive reproduction capability along with high-speed performance. Incorporated into laser via-hole*6 drilling devices and 3D molding devices, they play an instrumental role in the processing of high-density circuit boards for mobile phones, and the production of flat panel displays and solar panels.

*5 Galvano scanner
A scanner that applies a system employing a high-sensitive ammeter, or galvanometer. The word galvano is derived from the name of Italian physicist Luigi Galvani.

*6 Via-hole
A hole used for connecting circuit wiring created on each substrate in multi-layered substrates.

Galvano Scanner



Example of Galvano Scanner Application: Laser Via-Hole Drilling

Micro Laser Interferometer

Ultra-Sensitive Displacement Detection at 0.08 nm

Laser interferometers employ laser light for noncontact measurement of the movement (displacement and vibration) of objects with reflective surfaces. Canon developed a microlaser interferometer based on the Michelson interferometer method*7 that achieves an ultra-high resolution of 0.08 nm.

The light and compact interferometer weighs about 50 grams and measures a mere 38 mm (W) x 47 mm (D) x 19 mm (H) due to a unique optical design utilizing semiconductor lasers. This compact size enables the device to be used in piezo-electric measurement in automobile fuel injection equipment, wafer-stage position controllers for EB (Electron Beam) lithography and semiconductor lithography equipment, and microvibration analyzers in precision driving machines.

Micro Laser Interferometer

*7 Michelson interferometer method
Light from a light source is split into two or more beams and the light reflected by the object (measurement light) is recombined with the light reflected by a fixed reflective surface (reference light).

Ultrasonic Motor (USM)

Driving Focus and Zoom Mechanisms Using Ultrasonic Vibration

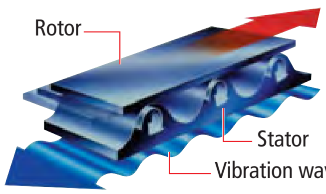
Canon developed the world's first ultrasonic motor (USM) for the autofocus of EF lenses for EOS series single-lens reflex cameras.

Ultrasonic motors work on the principle that a stator (the elastic body) subject to silent vibration with a predefined waveform results in friction that drives a rotor (the moving body). Small vibrations are repeatedly employed to induce motion, making possible low-speed movement with considerable force without needing a reduction gear mechanism. This type of motor produces higher torque than an electromagnetic motor, and also provides the same amount of torque with smaller dimensions without such drawbacks as cogging.*8 Highly precise operation and low noise are also major features of ultrasonic motors.

*8 Cogging
Electromagnetic motors are powered using the electromagnetic attraction of electromagnets and permanent magnets, generally resulting in jerky movement called cogging.

Micro USMs are used in the zoom lenses of compact digital cameras, etc.

From Left: Ring USM, Micro USM, and Micro USM II



USMs convert ultrasonic vibrations into linear or rotary motion

Principle of the USM

Production Engineering Technologies

Production engineering technologies for next-generation manufacturing are as important as those used in product development. These help realize fully automated production lines that run 24 hours a day year round, enabling in-house production of key components and processing tools that provide new functionality, higher performance, and lower costs, as well as cutting-edge nano-order processing and measuring technologies.

Toner Cartridge Production System

Fulfilling Advanced Cost, Space, and Reliability Needs

Automating production systems is an extremely effective way to improve production speed and product quality while cutting costs. Aiming to make the company even more competitive, Canon endeavors to establish automated production lines*1 that run 24 hours a day, 365 days a year.

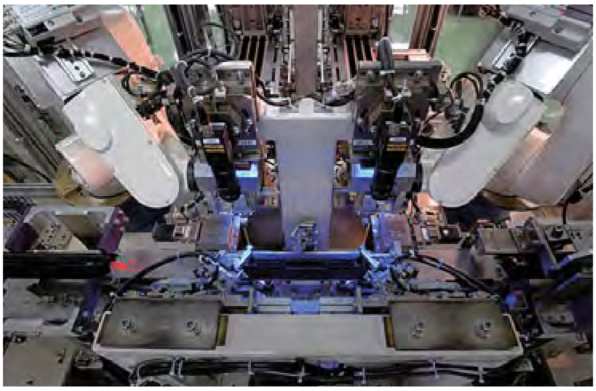
Canon has automated several hundred processes required in the production of toner cartridges for Canon laser printers, from parts processing and assembly to inspection and packaging. One of the technologies enabling this achievement is the Automated Moltopren Sealing Apparatus used to seal the toner. Moltopren, a sealing material formed from sponge and double-sided tape, had been considered difficult to handle in automated procedures due to its susceptibility to deformation caused by fluctuations in temperature, humidity, and tensile force. Drawing on its proprietary technologies, however, Canon completely automated the moltopren sealing process, from the supply procedure to cutting, processing, precision sealing of containers, and inspection. A proprietary high-precision dispenser is also used to apply grease and other fluid substances.

These production systems are uniquely developed and designed by Canon. Employing the latest technologies, including 3-D CAD, analysis simulation, and virtual reality, Canon is working to quickly create new production systems for use in production lines. Targeting the cutting edge of production technology, Canon is actively pursuing the realization of fully automated production lines.

*1 Automated production line
Used in the assembly of toner and ink cartridges. These lines achieve a yield (non-defective product rate) of almost 100%. These low-cost, space-saving, highly reliable lines are now in operation in several plants in Japan. Canon also launched such a line in Virginia in the United States in 2010.

Canon's toner cartridges use a unique "all-in-one" construction (developed in 1982) combining a photosensitive drum, a charging unit, a cleaner, and a developing unit. Because they are easy to handle, they lend themselves to simple maintenance and recycling.
◆Canon has obtained hundreds of patents for compact and all-in-one cartridge technologies
◆Used cartridges have been collected and recycled worldwide since 1990

All-in-One Toner Cartridge



Automated Toner Cartridge Production Line

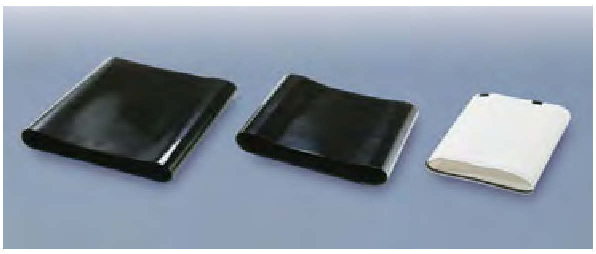
Chemical Component Technologies

Materials that Deliver Well-Balanced Functionality

Components and materials that support the functionality of products are called functional components, and at Canon, these include components used in digital MFPs and laser printers, such as high-image quality fixing materials, electrostatic-transfer and intermediate-transfer belts, electric-separation-transfer and electrical-charging rollers, and low-friction blades. Canon performs detailed analyses of the physical phenomena that take place during each process of a product's operation and, after thoroughly assessing the necessary properties, carries out the in-house development and manufacture of materials capable of delivering the required functions.

Specifically, Canon adapts raw materials from basic organic and polymeric materials, including plastics and rubbers, by applying chemical reactions, degeneration, and blending, followed by additional processing steps that make these materials appropriate for use as components. These technologies are called chemical-component technologies. Canon is also working on the in-house production of processing systems for functional components.

Rollers Used in Digital MFPs and Laser Printers



Transfer Belts Used in Digital MFPs and Laser Printers

Processing and Measurement System Technologies

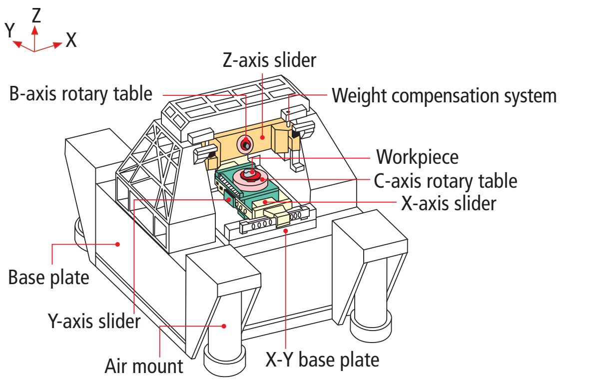
Achieving Nanometer-Order Precision in Optical Elements

With advances in design technologies, optical elements like lenses and prisms continue to evolve from spherical to aspherical shapes, and from axisymmetric to free-form surfaces. Optical elements that demand nanometer-order*2 levels of precision require the development of unique processing and measurement systems to process free-form surfaces with large variations in curvature.*3

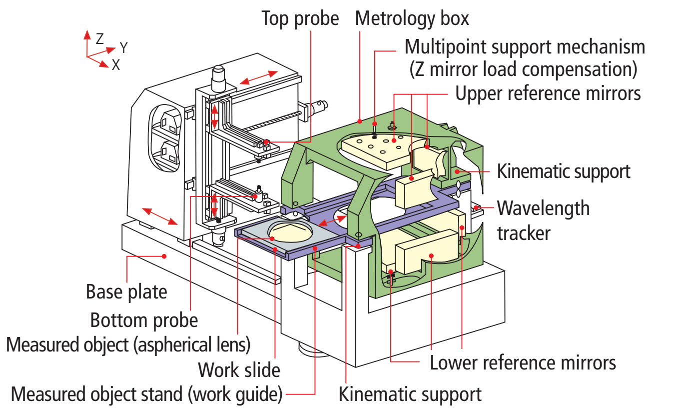
For its free-form processing machine, Canon developed various proprietary technologies that enable the high-precision control of the high-speed cutting tool, including highly rigid air bearings and a high-performance controlling system. The company's free-form measurement machine, which makes possible the ultra high-precision measurement of the entire surface of an optical element through contact probes that touch the element, also employs a variety of advanced technologies. A metrology box with a unique box-shaped structure provides the system's precision standard, while a laser interferometer comprising a work guide sandwiched between six mirrors is used to cancel contact-probe motion errors, making possible measurements of nanometer-order precision.

*2 Nanometer-order
A level represented by nanometer units (nm) of 1 nm (one millionth of a millimeter) to 1,000 nm (one thousandth of a millimeter). In this nano world, even the tiniest variations in temperature or pressure can significantly affect precision. Accordingly, equipment must maintain strict precision standards and steps must be taken to cancel all errors for items affected within the system.

*3 Curvature variation
Curvature is a number indicating the degree of curvature of lines and surfaces. Because the curvature of free-form lenses is not constant and changes greatly, special processing technology is required.



Free-Form Processing Machine (A-Former)



Free-Form Measurement Machine (A-Ruler)

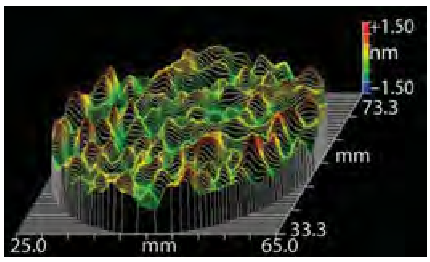
IBF (Ion Beam Figuring) Processing Technology

Fabricating Multi-Layer Mirrors with Atomic Precision

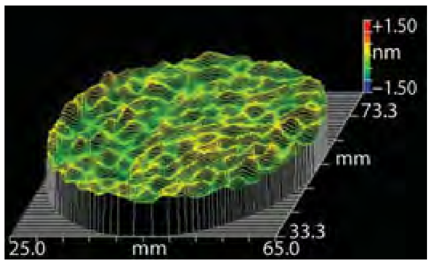
Exposure equipment operating in the EUV*4 wavelength range requires the use of multilayer mirrors that incorporate alternating layers of film made of different materials. These aspherical mirrors demand the most advanced levels of ultra-precision processing in the world, with accuracies at the atomic level (the radius of a hydrogen atom is approximately 0.1 nm*5). Canon is currently working on Ion Beam Figuring (IBF) technologies to refine the shape of mirrors.

IBF technology ensures high-precision figuring of the shape by using ion beams (IBs) without increasing surface roughness. Selecting the diameter of the IBs also makes it possible to correct shapes over a wide spatial frequency domain. In tests using Canon's original IBF system, a mirror with 0.36 nm RMS*6 in surface accuracy was successfully corrected to 0.13 nm RMS, achieving the world's highest level of surface accuracy and demonstrating the system's high-precision processing capabilities.

The development of the IBF system was consigned to the Extreme Ultraviolet Lithography System Development Association (EUVA) by the New Energy and Industrial Technology Development Organization (NEDO) as a theme in the organization's Extreme Ultraviolet Exposure System Development Project.



Surface accuracy before processing: 0.36 nm RMS



Surface accuracy after processing: 0.13 nm RMS

Results of Shape-Correction Testing Using a Mirror Material

*4 EUV : Extreme Ultraviolet

*5 nm (nanometers) : 1 nm = one billionth of a meter

*6 RMS
Root Mean Square. Also referred to as the mean square deviation; indicates the spread of values.

Molding Technologies

Enabling the Mass Production of High-Precision Aspherical Lenses and DO Lenses

The manufacture of aspherical lenses*1 and diffractive-optical elements*2 (DO lens → P.31), which are designed to diffract light on their surfaces, is made possible through mold-making technology, the most advanced technology used in lens production, as well as other proprietary Canon technologies.

● Photo Replication

In photo replication, a UV hardening resin is placed on an aspherical lens surface to transfer the mold shape and allowed to harden. After years of research into mold-making technologies to fabricate finely shaped molds as well as the characteristics and physical properties of resins, Canon has perfected technology that realizes nanometer-level precision in the controlling and transferring of fine shapes, enabling the manufacture of a range of lenses.

● Plastic Molding

Plastic molding involves pouring plastic into a finely fabricated aspherical mold to form a lens. This technology, used to produce items such as aspherical lenses for compact cameras, is based on innovations that ensure precise and stable molding.

● Glass Molding

Glass molding employs high-precision aspherical molds, which are pressed directly onto glass to shape it into lens elements. Based on studies of glass materials and mold materials, Canon conducted simulations to create molds that ensure consistent and accurate performance even at high temperatures. Glass-molded lenses have found wide application due to the flexibility of their refractive index and other optical parameters.


Molds for Manufacturing Aspherical Lenses


Large-Diameter Lens
For Liquid Crystal Projectors


Roof Prisms
For Lens-Shutter Cameras and Digital Cameras


Toric Lenses
For Laser Printers and Digital MFPs

*1 Aspherical lens
A lens that is not spherical, but has a curved surface (a surface with a curvature that continually changes in the direction of the lens diameter). Compared with spherical lenses, aspherical lenses minimize aberrations and can be used in both camera lenses and eyeglasses.

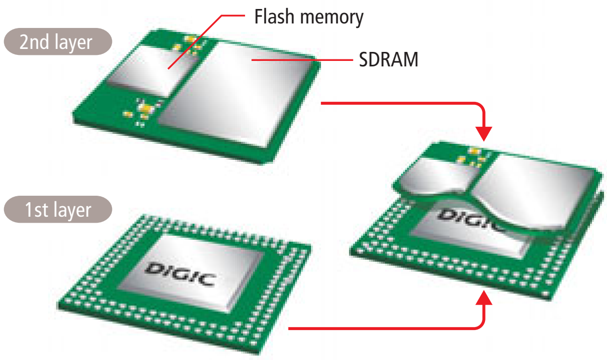
*2 Diffractive-optical element
A lens that includes both refractive and diffractive optical systems, and combines the two to achieve improved optical performance.

High-Density Packaging Technologies

Creating Smaller and Lighter Products

As semiconductors become smaller, faster, and more functional, digital products can be made smaller and lighter. Semiconductors are arranged on printed circuit boards within products, but as semiconductors become more advanced, they need to be packaged more densely at a smaller pitch. Canon has developed its own packaging technology, successfully making products smaller and lighter.

SiP (System in Package) technology integrates multiple semiconductors into a single package. CSP (Chip Scale Package) packaging technology forms solder balls on bonding pads on the back of the semiconductor package, allowing the chip to be bonded to the substrate by heating it. Canon is currently conducting R&D on simulation-analysis technologies to enhance the reliability of soldering connections between the package and substrate, and on solder-printing technologies, which are essential for high-precision soldering jobs.



SiP Concept Employed in Digital Cameras

Virtual Prototyping Technology

Promoting Prototype-Less Design Based on Optimization Analysis

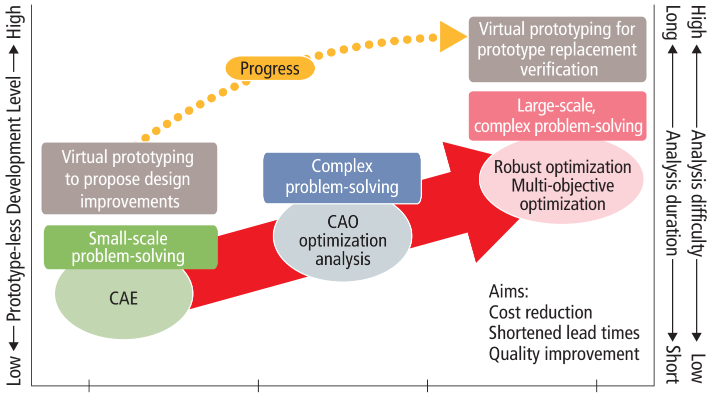
Computer-Aided Engineering (CAE),[*3] aimed at predicting and solving potential problems that may arise in product prototypes and production processes, is widely used in R&D, product development, production engineering, and prototyping at Canon. CAE combines "prototype-less core technology" with actual product analysis and measurement technologies to help speed up development cycles, reduce costs, and enhance product performance, functionality, and quality.

Virtual prototyping relies primarily on three technologies: 3D-Digital Mockup Review (3D-DMR)[*4] to identify problems in a basic product configuration using 3-D data, Computer-Aided Manufacturing (CAM)[*5] to automatically generate processing data, and CAE.

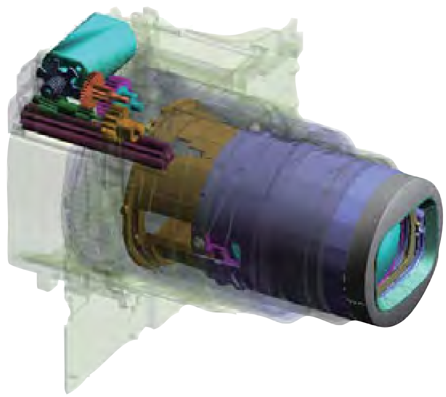
For CAE, the core technology, Canon is working to transform virtual prototyping from a means of verifying prototype replacement to a means of proposing improvements in the design phase, which takes full advantage of optimization analysis (CAO: Computer-Aided Optimization), multi-objective optimization analysis, and robust optimization analysis for stable functionality and performance.

Examples of virtual prototyping at Canon include optimization analysis for the zoom lens barrels in compact cameras. To ensure ease of assembly and disassembly, usability, safety, and drivability at the product-design stage, Canon uses CAE to perform multi-objective optimization analyses of the drive mechanisms for the entire product to simultaneously optimize multiple design goals.

For the compact camera zoom lens barrel pictured here, Canon performed multi-objective optimization analyses targeting two parameters—zoom lens drive time and power consumption, which have a tradeoff relationship—and derived a set of optimal Pareto solutions. From this set, engineers decided on a solution enabling a reduction of the zoom lens drive time by two-thirds while also reducing power consumption.



Progress of CAE Technology



Multi-Objective Optimization Analysis for a Zoom Lens Barrel

*3 CAE (Computer-Aided Engineering)
Systems for using computers to support design and development. In addition to aiding the design of products, it includes analysis of strength and safety, and simulations of functions and performance.

*4 3D-DMR (3D-Digital Mockup Review)
Virtual assembly technology

*5 CAM (Computer-Aided Manufacturing)
Systems for using computers to support manufacturing.

Quality Management Technologies

For Canon, as a manufacturer of precision products, technology that assures product quality is of great importance. Using a variety of assessment, simulation, and analysis technologies, the company constantly strives to maintain and improve its product quality. In 2008, a general measurement testing laboratory was completed at the company's Tamagawa plant, making it possible for the efficiency and accuracy of these operations to be significantly improved. Furthermore, this laboratory began operation as a certified public testing center in 2009.
Using advanced technology with a total commitment to "quality first" supports the safety and reliability of ever-evolving products.

Quality Assurance at Canon

To achieve Canon's corporate objectives of creating the world's leading products, offering the highest levels of quality and service, and contributing to the betterment of culture throughout the world, the company continually makes efforts to enhance quality by:

1. Identifying customer needs and utilizing the latest technologies to offer excellent high-quality products and speedy service
2. Making every effort to avoid causing harm or damage to consumers and their property as a result of nonconforming products or services

The message behind Canon product quality is to provide "safety, smartness, and satisfaction to customers." In order to deliver products and services to customers that fulfill these three objectives, Canon carries out quality assurance activities at every stage, from planning and development to production, marketing, and post-purchase services.

"Canon quality provides safety, smartness, and satisfaction to customers"
Safety: No breakdowns, no injuries, no defects
Smartness: Easy to use, well designed, reliable
Satisfaction: Great! Glad I bought it. It's Canon for me from now on.

Canon Quality
safety+smartness+satisfaction

Canon Quality Mark

Tamagawa Plant's General Measurement Testing Laboratory

Quality Assessment Center Contributing to Improved Product-Quality Levels

Canon has constructed a General Measurement Testing Laboratory at the Tamagawa Plant to serve as a center for quality evaluation and testing. The Laboratory comprises a number of different testing facilities: In the semi-anechoic chamber (EMC), for example, levels of electromagnetic radiation emitted by products are measured and immunity robustness from outside radio waves are tested, and the shield room makes it possible to investigate the possibility of product malfunction due to the effect of static electricity discharge and lightning surges; meanwhile, the hemi-anechoic room (Acoustics) and acoustic test lab are used to measure operation noise levels and other acoustic properties of products, and the safety evaluation room allows for testing of the flame retardant properties of products and components.

Some of these laboratories are certified testing facilities based on ISO/IEC17025. Certified testing facilities enable safety and EMC certification tests required for compliance with regulations such as EN55022 and FCC Part 15, the noise tests required for acquiring environmental marks such as ISO7779, and the third-party plastic fire safety tests based on regulations such as UL60950-1 A1 and A2 to be performed in-house, ensuring security and significantly reducing the time required for testing.

By conducting a variety of measurements utilizing the industry's top class of testing facilities, from the design phase, Canon is able to check safety, evaluate compliance with public regulations, and select safe components and materials. The General Measurement Testing Laboratory is contributing to the further improvement of the quality of Canon products.

Measurement of Electromagnetic Radiation Emitted by Products: Semi-Anechoic Chamber (EMC)

The General Measurement Testing Laboratory, Tamagawa Plant

Human-Scale Measurement and Evaluation Technologies

Evaluating Comfort and Ease-of-Use

Canon is currently working on the development of technologies capable of measuring and assessing the physiological reactions of users. By measuring such reactions in the form of brain waves, myoelectric potential, pulse, perspiration, and eye movement, it is possible to digitize the way in which people respond to products using their senses of sight, touch, smell, and hearing. The physiological data measured can then be combined with subjective observations in order to grade products with a high degree of accuracy, thus realizing a practical solution for human physiological evaluation.

For example, the amount of effort involved in unpacking an inkjet printer could be evaluated by simulating muscle load and measuring myoelectric potential, and by then combining this empirical data with subjective values. As a result, it was possible to efficiently review the length of packaging material handles to make the task of unpacking easier for users. Furthermore, similar research conducted during the design of large-format inkjet printers has – based on these evaluations – revealed the paper roll setting position that reduces the strain on a user's arms and back, and thanks to this approach, ease-of-use has been significantly improved.

Yet Canon is not focusing on operating effort alone; rather, the company is also working to evaluate empirical data pertaining to visual fatigue, mental stress, and other similar factors in the pursuit of products that are even more friendly to the user.

Measuring Physiological Reactions When Unpacking an Inkjet Printer

Chemical Safety Evaluation Technology

Preserving the Environment During Product Usage

Volatile organic compounds (VOCs), dust, ozone, particulates, and other chemicals emitted when a product is used must be reduced in order to minimize any harmful effect on the environment. Canon began full-scale measurement of chemical emissions in 2000 and boasts the highest level of measurement capability in the industry. In this field, the company has also made significant contributions to the creation of JIS and ISO standards.

In 2005, the company also became the first in the industry to have its chemical emission measurement laboratory awarded ISO/IEC17025 and German eco-label[*1] certification.

In addition, Canon has placed special emphasis on preventing the release of particulates, introducing a broad array of particulate measurement devices to its various facilities. These types of evaluation technologies have enabled Canon to work towards the minimization of emissions and many of Canon's products have been granted Germany's Blue Angel label and other prestigious labels.

Particulate Measurement Device

*1 Eco-labels
Labels that display the environmental friendliness of products. Products with ecolabels are certified as having reached the level specified in the labeling system. Germany's "Blue Angel" label, the first eco-label established in the world, has stringent certification standards.

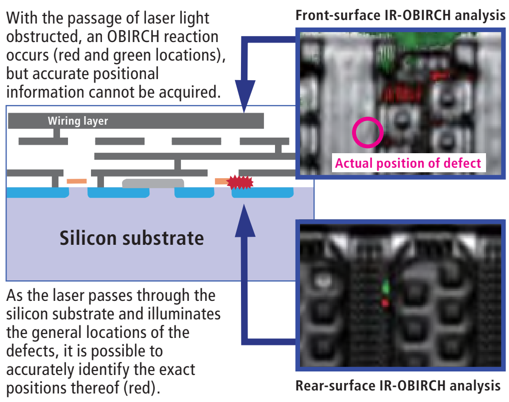
LSI Failure Analysis Technology

Guaranteeing Reliable Quality in Electronic Components

Absolute product quality can only be achieved by assuring reliable quality in each and every component part. At Canon, this quality assurance is undertaken for LSIs and other electronic components contained in company products by employing a unique component certification system and by also applying advanced technologies for evaluation and analysis.

An approach known as IR-OBIRCH[*2] is widely used in LSI failure analysis. This technology visualizes changes in resistance induced by applying heat locally via laser irradiation and identifies areas with abnormal current.

The infrared lasers used for this purpose have a wavelength longer than the bandgap[*3] of silicon, and as this allows the light to pass through LSIs with a silicon substrate, analysis can be performed at the rear, where no wiring layers exist. In the case of LSIs with multiple wiring layers, the passage of laser light is often obstructed by metal-film wiring, making it extremely difficult to identify the locations of defects through analysis of the front surface alone; however, the microscopic flaws causing current abnormalities can be detected via the rear. By investigating the causes of defects occurring during production or in the marketplace and ensuring that findings are fed back to component manufacturers, Canon can contribute to the assurance of much higher levels of product reliability.



Comparison of Front- and Rear-Surface Analysis of LSI Defects

*2 Optical Beam Induced Resistance CHange.
IR-OBIRCH is a variation on this approach using infra-red light.

*3 Bandgap
A bandgap is an energy range within which electrons cannot exist. In the case of silicon, this occurs at approximately 1,100 nm.

Environmental Technologies

In consideration of the environment, Canon promotes activities to reduce environmental impact in all three stages of the product lifecycle: Produce (development and manufacture), Use, and Recycle. As the basis of its efforts to minimize environmental impact, Canon also focuses on the development of unique environmental technologies to contribute to preserving the global environment.

High-Performance Bio-Based Plastics [Produce]

World's Highest Levels of Flame Retardancy

Produced using raw materials extracted from plants, bio-based plastics are extremely beneficial in terms of reducing environmental impact. However, their applications are currently limited due to issues with flame retardancy, shock resistance, heat resistance and moldability.

Canon and Toray, through the establishment of a new material design and molding technologies, were able to develop high-performance bio-based plastics with significantly improved material properties. Furthermore, the flame retardancy of this new plastic is the world's first bio-based plastic applicable for use in multifunction office systems to achieve 5V classification under the UL 94 flammability testing program.*1

This new material can be used not only in internal components, but also in external parts requiring a high level of flame retardancy, and Canon has employed it in its imageRUNNER ADVANCE series of MFPs. And with approximately 20% less CO_2 produced during production when compared with petroleum-based plastics, Canon plans to expand the range of applications in which bio-based plastics can be used.

A Product Employing Level 5V Bio-Based Plastic in its Exterior

*1 UL 94 standard
A safety standard set forth by Underwriters Laboratories of the United States and widely used in the grading of the flammability of materials. In accordance with this standard, plastics may be graded as 5V, V-0, V-1, V-2, or HB. Of these, 5V represents the most stringent set of conditions, and plastic having achieved the corresponding level of performance can be used as casing materials for large items of office equipment and home appliances.

Technologies for Replacing Volatile Organic Compounds [Produce]

Reducing VOCs in the Manufacturing Process

Organic solvent-based paint and cleaning agents are commonly used in a variety of parts processing. Canon is no exception, using organic solvents in the painting and cleaning processes for external components used in printers, cameras, and other products. These solvents produce VOC (Volatile Organic Compound) gases when used, creating a need to reduce emission levels.

Canon has been working on significantly reducing VOCs emissions by switching to low-VOC cleaners and paints, and introducing solvent recovery equipment.*2 At present, the company has begun to consider the use of water-based paint that does not contain VOCs. Canon has also significantly limited emissions in the cleaning process by switching to cleaners using low-diffusion VOCs that enable easy gas recovery and by introducing production equipment with recovery and recycling functions. Furthermore, the company is switching to low-VOC cleaning agents.

Production Equipment Capable of Recovering and Recycling Fluorine Solvents

*2 Solvent recovery equipment
Used for recovering and concentrating low-density VOC emissions, the technology enables the recovery of 90% or more of VOC emissions. High-density VOC emissions are liquefied and recycled during the cleaning process.

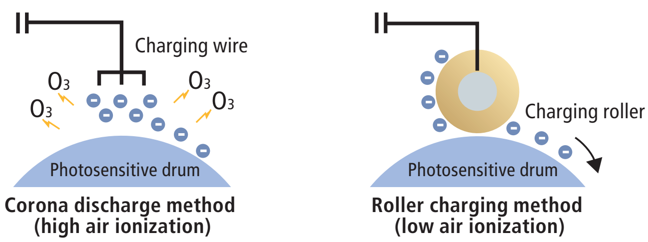
Ozone-Free Electrical Charging Technology [Use]

Reducing Ozone Emissions to Approximately 1/1000 or Less

Electrophotographic products such as digital MFPs and laser printers make use of an electrically charged photosensitive drum to generate images. The conventional corona charging method involves the application of voltages ranging from about 5 to 10 kV, which results in corona discharge*3 and generates ozone (O_3).

Eliminating the generated ozone required the introduction of an ozone filter, coupled with an airflow structure that reliably directs ozone to the filter.

To address this problem, Canon developed a roller charging method that charges the photosensitive drum by applying a voltage generated through the superposing of an AC voltage over a DC voltage to a conductive roller. Compared to the corona discharge method, which discharges into the air, this new method reduces ozone generation to levels no higher than about 1/1000, and voltage to about one-fifth of previous levels. The adoption of this technology eliminates the need for special systems to deal with ozone, enabling the realization of smaller digital MFPs and laser printers.



Overview of Ozone-Free Electrical Charging

*3 Corona discharge
A discharge phenomenon that occurs when voltage is applied to a pointed (needle) electrode and produces a light (corona) that can be seen in darkness.

Toner Fixing Technology [Use]

Dramatically Reduced Power Consumption in Standby Mode

In digital MFPs and laser printers, toner is fixed to the paper by heat and pressure via the fixing roller (→ P.19). With conventional fixing roller systems, the roller must be kept hot at all times by a heater located inside the roller, even when in standby mode.

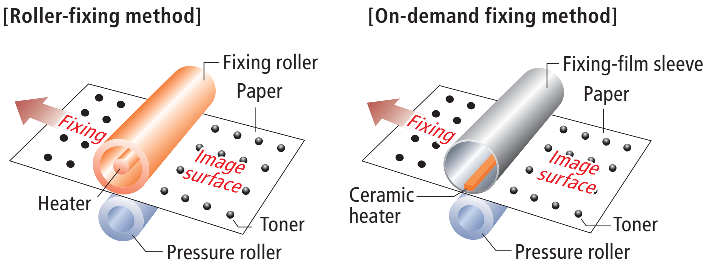
● On-Demand Toner-Fixing Technology (SURF)

Canon's on-demand toner-fixing technology employs a linear ceramic heater and a fixing film sleeve with high thermal conductivity and low thermal capacity. The thin fixing film is brought into contact with a ceramic heater, which operates only when the fixing film rotates, fixing the image by applying heat to the toner through the film. This mechanism eliminates the need for power while in standby and, in some products, realizes zero power consumption by the fixing unit when in standby.

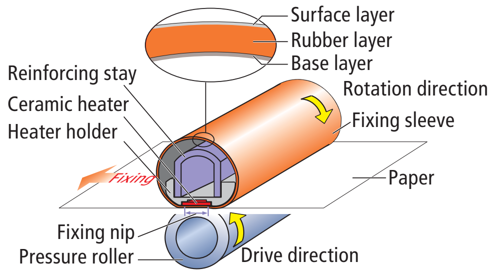
For color office machines, Canon developed color on-demand toner-fixing technology. The fixing belt uses a 3-layer structure in which a rubber layer, which improves the fixing of toner, is sandwiched between a base layer of monochrome fixing film and a surface layer. The base layer is made of either resin or metal, with the appropriate material chosen for each product in accordance with different product needs.

● Induction Heating Fixing Technology

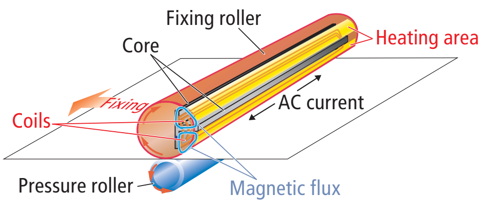
"Induction Heating (IH)"[*4] toner fixing" uses a fixing roller consisting of a thin-walled metal pipe with a thin coating. The roller is heated using induction heating by applying a high-frequency electrical current through a coil built into the roller. Because the self heating roller is subject to thermal change, ensuring durability had posed a challenge. Following an examination of the thermal properties of materials and the mechanical characteristics of the technology, Canon achieved an improved roller-holding method and fixing unit structure, and completed a highly durable fixing roller. To ensure stable temperature control, the company also developed a low-loss, high-frequency inverter power supply. This technology reduces standby times to one-tenth of previous wait times while cutting energy consumption by about 55% compared with previous systems (based on an in-house comparison).



On-Demand Toner Fixing System



Color On-Demand Fixing System



IH Fixing System

*4 Induction Heating (IH)
A heating method found in electric rice cookers and other cooking appliances that makes use of magnetic induction.

Toner Cartridge Recycling Technology [Reusage]

Successful Achievement of 100% Recovery

Canon led the way for the toner cartridge industry all over the world in the realization of a material recycling plant wherein various stages from toner-cartridge crushing to material separation and conversion into plastic pellets[*5] are carried out automatically. Plastic is the most commonly used material in the outer casing of toner cartridges, and after this has been efficiently separated with very high accuracy based on aspects such as color and weight, it is converted into pellets, enabling its reuse in new toner cartridges. The closed-loop recycling that Canon has achieved provides for the semi-permanent usage of plastic materials, which far surpasses the standard, conventional approach by which the materials ultimately have to be disposed of. Meanwhile, metals separated from the crushed material can also be put to use in other applications, thus eliminating the need for landfill disposal, and therefore, achieving a 100% recovery rate.

Materials Sorted Using Separation Technology

*5 Pellet
Small homogeneous particles or nurdles.

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Canon Technology Website

www.canon.com/technology

Please take a look at the "Canon Technology" website, which is filled with content such as that introduced in Technology Highlights.

There are also videos providing explanations of technology, interviews with developers discussing their thoughts and interesting episodes related to technology development, introductions of Members of the Canon Academy of Technology who have been certified within the company, and features such as "What is Light?" that explains the mysteries of the world of light, an essential part of our everyday lives.

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